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PROGRAM OF WORK

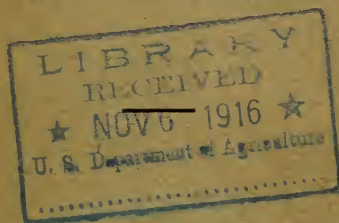
OF THE

UNITED STATES

DEPARTMENT OF AGRICULTURE

FOR THE

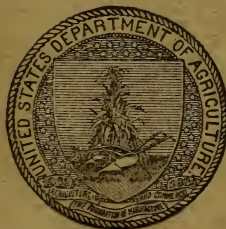
FISCAL YEAR 1917.



PREPARED UNDER THE DIRECTION OF THE
SECRETARY OF AGRICULTURE

By E. H. BRADLEY.

JULY 1, 1916.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1916.



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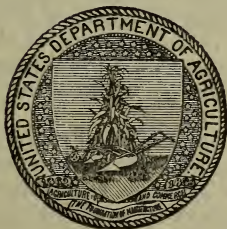
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EXPLANATORY NOTE.

The first printed edition of the Program of Work of the Department of Agriculture covered the fiscal year 1915 (July 1, 1914, to June 30, 1915). An issue in typewritten form was prepared for the preceding fiscal year (1914), but only a limited number of copies were made.

Inasmuch as this Program represents an attempt to forecast the work of the department for an entire fiscal year, it is necessarily somewhat tentative in character and subject to modification during the year.

The projects of each bureau and office in the department upon which it is proposed to undertake work are briefly outlined, with an indication of the object, cooperative relationships, assignment or leadership, and proposed expenditures for the fiscal year.

The department's activities are set forth under main groups, or principal lines of work, these being subdivided, where necessary or desirable, into projects covering specific phases of the work. The general arrangement follows as closely as possible the order of the appropriation items as they occur in the general agricultural appropriation act.

In a broad way, the work of the department is divided into three types of activity—(1) research, or the scientific study of the fundamental problems of agriculture; (2) extension or educational work, or the dissemination of the information developed through the department's experiments and discoveries; and (3) regulation, or administration of various statutes with whose enforcement the department is charged. As far as practicable, the projects of each bureau have been segregated on the basis of this classification.

The chief purpose of the Program of Work is to inform workers within the Department of Agriculture of the projects under way in each bureau and office, and thus to facilitate correlation of work and coordination of effort and to reduce the possibility of useless or harmful duplication.

A limited number of copies of the Program is also furnished to each of the State agricultural colleges and experiment stations, with the view of informing those agencies regarding the scope of the department's activities in relation to work being prosecuted by the State institutions.



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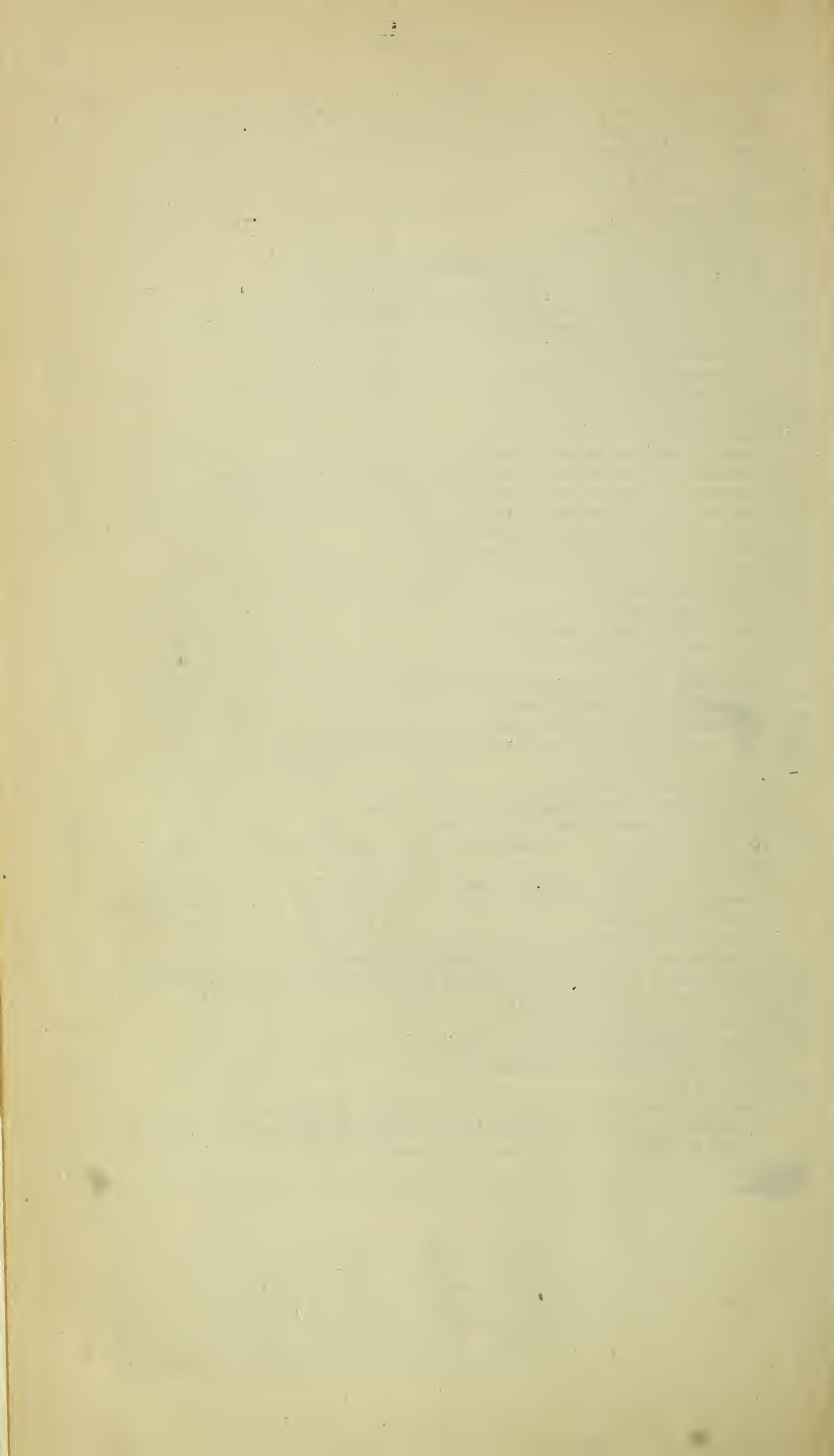
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PROGRAM OF WORK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEAR 1917.

OFFICE OF THE SECRETARY.

SECRETARY'S OFFICE.

Secretary's Office:

Object.—The Secretary of Agriculture is charged with the work of promoting agriculture in its broadest sense. He exercises general supervision and control over the affairs of the department and formulates and establishes the general policies to be pursued by its various branches.

Cooperation.—Congress, other departments, the respective States, and the several branches of this department.

Location.—Washington, D. C.

Date begun.—Department was created in 1862; raised to the rank of an executive department in 1889.

Assignment.—David F. Houston; F. R. Harrison, private secretary.

Proposed expenditures, 1916-17.—\$31,660 (statutory, \$27,060; miscellaneous expenses, \$2,200; lump-fund detail from Office of Markets and Rural Organization, \$2,400).

ASSISTANT SECRETARY'S OFFICE.

Assistant Secretary's Office:

Object.—The Assistant Secretary of Agriculture becomes Acting Secretary in the absence of the Secretary, and assists in the general supervision of the work of the department.

Cooperation.—Other departments and all branches of this department.

Location.—Washington, D. C.

Date begun.—The office of Assistant Secretary was created in 1889.

Assignment.—Carl Vrooman.

Proposed expenditures, 1916-17.—\$21,150 (statutory, \$13,650; miscellaneous expenses, \$2,000; lump-fund details from Bureau of Animal Industry and States Relations Service, \$5,500).

SOLICITOR'S OFFICE.

Solicitor's Office:

Object.—The Solicitor is charged by law (act of May 26, 1910) with the direction of the legal work of the department. Accordingly, he acts as legal adviser to the Secretary and the heads of the several branches of the department, conducts its legal work, and represents it in all legal matters. He approves, in advance of issue, all orders and regulations promulgated by the Secretary under statutory authority.

Cooperation.—All branches of the department, United States attorneys, etc.

Location.—Washington, D. C., Missoula, Mont., Portland, Oreg., Ogden, Utah, San Francisco, Cal., Denver, Colo., and Albuquerque, N. Mex.

Date begun.—1905 (General Order 85).

Assignment.—Francis G. Caffey.

Proposed expenditures, 1916-17.—\$96,560 (statutory, \$95,560; miscellaneous expenses, \$1,000).

DISBURSING OFFICE.

Disbursing Office:

Object.—To keep appropriate ledgers relative to the advance and disbursement of all items of appropriations and to pay all accounts properly certified by the various branches of the department.

Disbursing Office—Continued.

Cooperation.—All branches of the department.

Location.—Washington, D. C.

Date begun.—1862.

Assignment.—A. Zappone.

Proposed expenditures, 1916-17.—\$45,920 (statutory, \$44,920; miscellaneous expenses, \$1,000).

LIBRARY.**Library:**

Object.—To assist the workers of the department and the public in general by supplying literature on agriculture and kindred subjects. The library is charged with the purchase of all books and periodicals for the use of the department in Washington, and supervises their arrangement, cataloguing, and use; prepares bibliographies of special subjects, and also has charge of the foreign mailing lists for the department publications.

Cooperation.—All branches of the department, the Library of Congress, and other libraries in and outside of Washington, D. C.

Location.—Washington, D. C.

Date begun.—1862.

Results.—The library has been enriched by approximately 9,000 accessions during the fiscal year ended June 30, 1916, not including current numbers of periodicals. Approximately 2,300 periodicals were received currently. Approximately 81,000 books and 175,000 current periodicals were circulated.

Assignment.—Claribel R. Barnett.

Proposed expenditures, 1916-17.—\$49,520 (statutory, \$31,520; general expenses, \$18,000).

OFFICE OF INFORMATION.**Office of Information:**

Object.—To secure the widest possible circulation for the discoveries and recommendations of the scientists, specialists, and field workers of the department, agricultural advice, warnings, and information as to regulatory matters; and to supply the public press with facts taken from publications and also from oral statements of specialists in a form to attract attention and lead to the adoption of the methods recommended. A specialized information service exclusively for agricultural papers has been inaugurated. The office also issues a Weekly News Letter containing seasonal and other information in a popular form.

Cooperation.—All branches of the department.

Location.—Washington, D. C.

Date begun.—1913.

Assignment.—G. W. Wharton.

Proposed expenditures, 1916-17.—\$15,810 (statutory, \$13,300; miscellaneous expenses, \$2,510).

OFFICE OF INSPECTION.**Office of Inspection:**

Object.—To act as the clearing house of the Secretary's office in fiscal transactions between the bureaus and claimants and otherwise assist in the fiscal operations of the bureaus; to handle fiscal correspondence between the Secretary's office and the Treasury Department and personnel inspection matters; and to prepare certain annual and other reports.

Cooperation.—All branches of the department.

Location.—Washington, D. C.

Date begun.—1914.

Assignment.—Alex. McC. Ashley.

Proposed expenditures, 1916-17.—\$21,620 (statutory, \$21,280; miscellaneous expenses, \$340).

OFFICE OF EXHIBITS.**Office of Exhibits:**

Object.—To handle the correspondence of the department relative to exhibits at fairs and expositions of various kinds; cooperate with the several branches of the department in preparing exposition material; ship, install, display, and care for such exhibits; and investigate methods of displaying them. During the present year the office is supervising and demonstrating the exhibit of the department at the Panama-California International Exposition, San Diego, Cal., and will make preparations for and conduct exhibits at various other fairs throughout the United States.

Office of Exhibits—Continued.

Cooperation.—All branches of the department, State Department, Government Exhibit Board, State colleges and experiment stations, and fair, exposition, and show associations of various kinds throughout the United States.

Location.—Washington, D. C.

Date begun.—1913.

Results.—Since July 1, 1913, has handled agricultural exhibits at the following expositions: International Congress of Refrigeration, Chicago, Ill.; National Conservation Congress, Knoxville, Tenn.; International Dry-Land Congress, Tulsa, Okla.; United States Land Show, Chicago, Ill.; Sixth National Corn Exposition, Dallas, Tex.; Forest Products Expositions, Chicago, Ill., and New York, N. Y.; International Dry-Farming Congresses, Wichita, Kans., and Denver, Colo.; Panama-Pacific International Exposition, San Francisco, Cal.; Panama-California International Exposition, San Diego, Cal.; Panama National Exposition, city of Panama; Philadelphia Today and Tomorrow Civic Exposition, Philadelphia, Pa.; Government Safety-First Train; and numerous minor fairs, expositions, displays, etc. Has handled all matters relative to expositions and exhibits, and acted as a center for information upon this subject.

Assignment.—F. Lamson-Scribner.

Proposed expenditures, 1916-17.—\$40,909 (statutory, \$5,040; miscellaneous expenses, \$500; International Farm Congress and Soil-Products Exposition, \$20,000; National Dairy Show Association, \$15,000; allotment from bureaus for rent, \$369).

OFFICE OF FOREST APPEALS.**Office of Forest Appeals:**

Object.—Created for the purpose of having, under the immediate supervision of the Secretary, an officer independent of the Forest Service, by whom appeals from the decision of that bureau affecting land claims and land classification matters might be passed upon, after a careful examination of the record and a consideration of the questions involved, in order that the Secretary might thus be assisted in reaching a final decision. At the direction of the Secretary the office also cooperates with the Office of Inspection in the investigation of personnel cases involving discipline, demotion, or dismissal, and complaints by or against bureau or department officers.

Cooperation.—Forest Service, in appeal cases; Office of Inspection, in connection with personnel cases.

Location.—Washington, D. C.

Date begun.—1913.

Results.—During the past year the following matters have been considered and recommendations made thereon for action by the Secretary: 84 cases on appeal, 15 petitions for review of Secretary's decisions, 2 motions to allow appeal, and 4 complaints.

Assignment.—Thos. G. Shearman.

Proposed expenditures, 1916-17.—\$5,250 (statutory, \$1,200; miscellaneous expenses, \$50; lump-fund detail from Forest Service, \$4,000).

CHIEF CLERK'S OFFICE.**Chief Clerk's Office Proper:**

Object.—The chief clerk has general supervision of clerks and employees, of the records and correspondence of the Secretary's office, and of expenditures from appropriations for miscellaneous expenses, rent of buildings, etc. He is responsible for the enforcement of the general regulations of the department and is custodian of the buildings. This project includes work of the time clerk, operation of the telephones and telegraph, and provision for miscellaneous supplies and services for the department as a whole.

Cooperation.—Various branches of the department.

Location.—Washington, D. C.

Date begun.—1862.

Assignment.—R. M. Reese.

Proposed expenditures, 1916-17.—\$50,420 (statutory, \$17,160, exclusive of \$2,100, details to Division of Publications; extra labor, \$5,000; miscellaneous expenses, \$28,260).

Appointment Clerk's Office:

Object.—To prepare all papers relating to appointments, transfers, promotions, reductions, details, furloughs, and removals; to keep personal records of employees, etc.

Cooperation.—All branches of the department.

Location.—Washington, D. C.

Date begun.—1891.

Assignment.—R. W. Roberts.

Proposed expenditures, 1916-17.—\$16,080 (statutory, \$15,320; miscellaneous expenses, \$760).

Supply Section:

Object.—To make purchases of stationery and miscellaneous supplies for the Office of the Secretary and the various bureaus; and to receive and dispose of, by sale or otherwise, all property turned in by the various bureaus and offices when of no further use; also to sell unused samples of products secured in connection with the enforcement of the food and drugs act and the insecticide act.

Cooperation.—All branches of the department.

Location.—Washington, D. C.

Date begun.—About 1883.

Assignment.—C. B. Lower.

Proposed expenditures, 1916-17.—\$14,920 (statutory, \$8,020, including \$720 detail from Bureau of Plant Industry; miscellaneous expenses, \$6,900).

Mail and Files:

Object.—To receive, record, and distribute mail for the Office of the Secretary; index, copy, file, and dispatch correspondence. The department post office receives, distributes, and dispatches mail handled between the city post office and the several bureaus.

Cooperation.—Other branches of the department.

Location.—Washington, D. C.

Date begun.—1862.

Results.—Approximately 400,000 letters, papers, etc., handled during the year.

Assignment.—Joseph Haley.

Proposed expenditures, 1916-17.—\$16,120 (statutory, \$15,420; miscellaneous expenses, \$700).

Watch Force:

Object.—To protect and watch 19 buildings occupied by the department, in three shifts, covering the entire 24 hours.

Location.—Washington, D. C.

Date begun.—1862.

Assignment.—F. C. More.

Proposed expenditures, 1916-17.—\$43,260 (statutory, \$38,760, exclusive of \$2,440, details to Bureau of Plant Industry; extra labor, \$4,000; miscellaneous expenses, \$500).

Char and Labor Force:

Object.—To clean and keep in sanitary condition the halls and toilets of the department buildings and to clean the rooms in the different units of the Office of the Secretary.

Cooperation.—Various branches of the department.

Location.—Washington, D. C.

Date begun.—1862.

Assignment.—R. M. Reese, H. W. Barker.

Proposed expenditures, 1916-17.—\$23,220 (statutory, \$20,120, including \$480 detail from Division of Publications; miscellaneous expenses, \$3,100).

Stables:

Object.—To feed, care for, and drive the horses, and care for the vehicles used by the Office of the Secretary and the Division of Publications.

Location.—Washington, D. C.

Date begun.—Many years ago.

Assignment.—R. M. Reese.

Proposed expenditures, 1916-17.—\$10,230 (statutory, \$6,720; miscellaneous expenses, \$3,510).

Rent in the District of Columbia:

Object.—To administer the appropriation for rent in the District of Columbia for the various branches of the department, 22 buildings and parts of buildings being under rental.

Rent in the District of Columbia—Continued.

Location.—Washington, D. C.

Date begun.—Many years ago.

Assignment.—R. M. Reese.

Proposed expenditures, 1916-17.—\$133,689 (including \$10,000 from appropriation for meat inspection, Bureau of Animal Industry).

Total, Chief Clerk's Office, \$307,939.

MECHANICAL SUPERINTENDENT'S OFFICE.**Power House:**

Object.—Supervision of engineers and firemen, except those of the Weather Bureau, and provision of heat, light, power, and electricity for all buildings of the department in Washington, except those occupied by the Weather Bureau, Forest Service, and Office of Public Roads and Rural Engineering.

Cooperation.—Various branches of the department.

Location.—Washington, D. C.

Date begun.—1908.

Assignment.—J. N. Caughell.

Proposed expenditures, 1916-17.—\$52,320 (statutory, \$14,320; miscellaneous expenses, \$38,000).

Mechanical Force:

Object.—Maintenance of mechanical shops for the repair and upkeep of the buildings, laboratories, and equipment, including electrical, carpenter, and cabinet work, plumbing, painting, rubber-stamp making, and operation of elevators.

Cooperation.—Various branches of the department.

Location.—Washington, D. C.

Date begun.—1909.

Assignment.—J. N. Caughell, C. C. Wilson.

Proposed expenditures, 1916-17.—\$103,350 (statutory, \$74,080; extra labor, \$3,000; miscellaneous expenses, \$23,670; lump-fund details from Bureau of Chemistry, \$2,600).

Total, Mechanical Superintendent's Office, \$155,670.

OFFICE OF FARM MANAGEMENT.

GENERAL ADMINISTRATION.

Office of Chief:

Object.—To supervise the investigations relating to farm management and farm practice.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—W. J. Spillman, chief; E. H. Thomson, assistant chief.

Proposed expenditures, 1916-17.—\$11,810.

Office of Executive Assistant:

Object.—General supervision of the fiscal affairs of the office and of the clerical force and janitor service; the handling of mails; operation and maintenance of central file and property room, photographic laboratory, and library; all matters pertaining to appointments, pay rolls, and leaves of absence.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—Lisle Morrison.

Proposed expenditures, 1916-17.—\$22,732.

Editorial Work:

Object.—To edit and prepare for printing manuscripts and to read and revise proofs of articles submitted for publication by investigators of the office; also similar work in connection with all printing required by the office.

Location.—Washington, D. C.

Date begun.—1915.

Assignment.—Raymond Evans.

Proposed expenditures, 1916-17.—\$3,250.

Total, General Administration, \$37,792, including \$27,370 statutory.

[Research.]

INVESTIGATIONS IN FARM ECONOMICS.

CROP ECONOMICS.

Cost of Growing Sugar Beets:

Object.—To investigate farm practice in the production of sugar beets, the equipment required, the cost of production, the profitableness of the enterprise, and the geographic and economic conditions which render this crop desirable as a part of the farm business.

Procedure.—Cost-accounting studies are made on a number of farms in districts where sugar beets are of primary importance. The results from these field investigations are compiled and summarized to determine the best farm practice, as well as the economic factors involved.

Cooperation.—Office of Sugar-Beet Investigations, Bureau of Plant Industry; and various farmers in different parts of the country.

Location.—Important sugar-beet producing districts in Michigan, Ohio, Colorado, Utah, Idaho, Montana, and California.

Date begun.—1910.

Results.—During the past year 1,314 enterprise records were secured in several typical sugar-beet areas. These schedules have been summarized, and the results are being compiled for publication. So many factors exert an influence on the results of a single year that it has seemed desirable to check the records for at least two successive seasons. Additional data will therefore be obtained from sugar-beet areas during the summer of 1916. Prior to last year the work under this project was of a preliminary character.

Assignment.—L. A. Moorhouse, T. H. Summers, R. S. Washburn.

Proposed expenditures, 1916-17.—\$9,840.

Cost of Producing Hay and Grasses:

Object.—This project deals with crew management in making hay, the equipment required, the cost of production, profitableness of the enterprise, and the geographic and economic conditions which make hay crops desirable.

Procedure.—Cost-accounting studies are conducted on a number of farms in each of the districts where the hay crop is of primary importance. These field investigations are compiled and summarized to determine the best farm practice and the most efficient methods.

Cooperation.—Bureau of Plant Industry.

Location.—Important hay-producing districts in the various States.

Date begun.—1910.

Results.—Data on the cost of production have been obtained by field studies in New York, Pennsylvania, Iowa, Nebraska, Kansas, and Oklahoma. These data will soon be ready for publication. The following bulletins and circulars have been published: Farmers' Bulletins—362, "Conditions Affecting the Value of Market Hay"; 508, "Market Hay"; and 677, "Growing Hay in the South for the Market"; and Bureau of Plant Industry Circular 131, "Measuring Hay in Ricks or Stacks."

Assignment.—H. B. McClure.

Proposed expenditures, 1916-17.—\$3,680.

Cost of Growing Potatoes:

Object.—To investigate farm practice in the production of Irish potatoes, the equipment required, the cost of production, profitableness of the enterprise, and the geographic and economic conditions which render this crop desirable as part of the farm business.

Procedure.—Cost-accounting studies are made on a number of farms in districts where potato growing is of primary importance. The results of these field investigations are compiled and summarized to determine the best farm practice as well as the economic factors involved.

Cooperation.—Bureau of Plant Industry.

Location.—Important potato-producing districts in 19 States, extending from Maine to California.

Date begun.—1912.

Results.—Nearly 900 records have been collected and compiled on the cost of growing potatoes from the various potato-producing districts. The publication of these results is awaiting results of corroborative studies in these same districts.

Assignment.—Harry H. Clark, L. L. Corbett.

Proposed expenditures, 1916-17.—\$3,120.

Cost of Producing Cotton:

Object.—To study farm practice in the production of cotton, equipment required, cost of production, and profitableness of the enterprise.

Procedure.—Cost-accounting and survey studies are conducted on a large number of farms where cotton growing is of primary importance. The results from these field investigations are compiled and summarized to determine the cost of growing cotton and the most efficient methods of farm practice.

Location.—Important cotton-producing districts in the Southern States.

Date begun.—1913.

Results.—Extensive investigations have been made in nearly all the important cotton-producing States, giving several hundred records from representative growers. These have been compiled, and two manuscripts are ready for publication. The study of the cost of producing cotton has been carried on in connection with the farm-survey and farm-organization investigations.

Assignment.—C. L. Goodrich, H. M. Dixon, J. S. Ball.

Proposed expenditures, 1916-17.—\$1,210.

Cost of Producing Corn Silage:

Object.—To investigate farm practice in the production of corn silage, the equipment required, cost of production, and the profitableness of the enterprise. Data are also desired on the capacity of silos, shrinkage, etc. Information of this nature is needed in planning cropping systems for farms where live stock is kept.

Procedure.—Cost-accounting studies are made on a number of farms in districts where corn silage is an important crop. Careful tests and weighings of silage are made in cooperation with farmers. The results of these field investigations are being compiled and will be presented for publication during 1916.

Cost of Producing Corn Silage—Continued.

Cooperation.—New York, Wisconsin, and Minnesota agricultural experiment stations.

Location.—Important silage-growing districts in the Northern States.

Date begun.—1906.

Results.—Several hundred records have been collected on the cost of growing silage, and detailed cost-accounting studies have been made covering a long period of years on certain farms. Careful weighings have been made on a number of farms to determine the capacity of silos and the shrinkage of silage.

Assignment.—C. M. Bennett, H. G. Strait, M. R. Cooper.

Proposed expenditures, 1916-17.—\$4,990.

Cost of Fruit Production:

Object.—To investigate orchard practice in the production of fruits, the equipment required, cost of production, profitableness of the enterprise, and the geographic and economic conditions which render these crops desirable as a part of the farm business.

Procedure.—Cost-accounting studies are made on a number of farms in each of the districts where fruit growing is of primary importance. The results from these field investigations are summarized to determine the best farm practice as well as the economic factors involved.

Cooperation.—Bureau of Plant Industry.

Location.—Important fruit-growing districts in Washington, Oregon, California, Idaho, Colorado, Missouri, New York, Virginia, West Virginia, and the New England States.

Date begun.—1912.

Results.—Nearly 1,000 records have been taken on farms where the orchard is an important enterprise. These data deal with the orchard practices followed, the time required to perform the various operations, and the cost of same. Four manuscripts have been prepared on the cost of growing apples in the Rocky Mountain and Northwestern States. Department Bulletin 130, "Operating Costs of a Well-Established New York Apple Orchard," has been published.

Assignment.—G. H. Miller, S. M. Thomson.

Proposed expenditures, 1916-17.—\$5,780.

Economics of the Farm Wood Lot:

Object.—To procure data over a wide range of the wood-lot sections of the United States which will bring out the actual and relative importance of the farm wood lot in relation to the general profitableness of the farm business.

Procedure.—Sixteen typical sections of the country will be visited, in each of which 50 to 75 farms will be inspected and data obtained on the problems under investigation. It is estimated that it will take two years to complete this work, when a bulletin will be prepared reporting the results obtained.

Cooperation.—Forest Service.

Location.—Headquarters, Washington, D. C.

Date begun.—1915.

Assignment.—E. R. Hodson.

Proposed expenditures, 1916-17.—\$900.

Total, Crop Economics, \$29,520, including \$2,200 statutory.

LIVE-STOCK ECONOMICS.**Cost of Producing Feeder Cattle:**

Object.—To determine the cost of producing feeder cattle on farms and ranches under different conditions and for different sections of the country, with special reference to the successful economic management of the farm as a whole and the profits realized therefrom.

Procedure.—Careful cost-accounting studies are made on a large number of farms and ranches where the raising of feeder cattle is an important enterprise. An investigation of different methods of herd management in common practice and of their relative efficiency is conducted. Financial analyses are also made to determine the relation of the profitableness of this enterprise to the farm business generally.

Cooperation.—Bureau of Animal Industry.

Location.—Headquarters, Washington, D. C.

Date begun.—1914.

Cost of Producing Feeder Cattle—Continued.

Results.—Several hundred records have been obtained from farmers in the Central West showing the methods used in and the cost of raising feeder cattle, which includes both the cost of maintaining breeding herds and of raising calves. As many factors exert an influence on the cost of animal production, it has seemed desirable to continue these studies for a period of years, not only in the Middle West but in other important live-stock regions, so that authoritative results may be available. A statement of the investigations to date is published in Report 111, Office of the Secretary, "Methods and Cost of Growing Beef Cattle in the Corn-Belt States."

Assignment.—J. S. Cotton, M. O. Cooper.

Proposed expenditures, 1916-17.—\$4,200.

Cost of Finishing Beef Cattle:

Object.—To investigate the cost of finishing beef cattle and the relation of this enterprise to the profitableness of the farm business.

Procedure.—Same as preceding project.

Cooperation.—Bureau of Animal Industry.

Location.—Headquarters, Washington, D. C.

Date begun.—1914.

Results.—In the investigation of the cost of producing feeder cattle several hundred records were obtained. These same cattle will be followed through to the time of marketing, thereby giving the cost of finishing same. The results of this particular study will not be available for another year.

Assignment.—J. S. Cotton, M. O. Cooper.

Proposed expenditures, 1916-17.—\$3,900.

Cost of Producing Baby Beef:

Object.—To determine the cost of producing baby beef on farms and ranches under different conditions and for different sections of the country. Complete data are required on the methods used in and the cost of maintaining breeding herds, as well as similar data on the raising of calves. Special attention is given to determining such economic factors as make baby-beef production a desirable farm enterprise.

Procedure.—Same as preceding project.

Cooperation.—Bureau of Animal Industry.

Location.—Headquarters, Washington, D. C.

Date begun.—1914.

Results.—A report on the cost of producing baby beef on a large number of farms in the Central West is contained in Report 111, Office of the Secretary.

Assignment.—J. S. Cotton, M. O. Cooper.

Proposed expenditures, 1916-17.—\$4,820.

Cost of Raising Colts and the Maintenance of Farm Work Horses:

Object.—To investigate the cost of keeping farm work horses under different conditions and in different sections of the country; to determine the cost of raising colts and the relation of this enterprise to the cost of horse labor.

Procedure.—Cost-accounting studies have been made over a long period of years whereby accurate data are available on the rations used and all other expenses involved in the cost of maintaining farm work horses. These studies include data on the cost of raising colts on these farms. Data have also been collected on the hours of work performed by farm work horses and on the relation of the amount of work to the cost of keeping.

Cooperation.—New York, Wisconsin, and Minnesota experiment stations.

Location.—Headquarters, Washington, D. C.

Date begun.—1906.

Results.—A large number of records on the cost of keeping work horses have been collected and compiled, and a manuscript is being prepared for publication. These results treat the subject in detail both as to costs and work accomplished by the farm horses considered.

Assignment.—M. R. Cooper.

Proposed expenditures, 1916-17.—\$2,420.

Cost of Producing Dairy Cattle:

Object.—To determine the cost of producing dairy cattle on farms under different conditions and in different sections of the country, with special reference to the profitableness of the entire farm business.

Cost of Producing Dairy Cattle—Continued.

Procedure.—This investigation is carried on in connection with cost-accounting and other studies where records are obtained on the entire farm business and on which the raising of dairy cattle is one of the important farm enterprises.

Cooperation.—New York, Wisconsin, and Minnesota experiment stations.

Location.—Headquarters, Washington, D. C.

Date begun.—1906.

Results.—Carefully kept records over a period of years are being obtained from a number of farmers on the cost of raising dairy cows. Department Bulletin 49, "The Cost of Raising a Dairy Cow," has been issued.

Assignment.—C. M. Bennett, M. O. Cooper.

Proposed expenditures, 1916-17.—\$1,460.

Cost of Producing Dairy Products with Relation to the Profits of the Farm Business:

Object.—To investigate the cost of producing various kinds of dairy products, such as milk, butter, and cheese, under different conditions and in different sections of the country. This includes a study of the labor requirements, the capital necessary where the different types of dairying are practiced, and the profits realized therefrom. Special attention is given to the relation of the dairy enterprise to the profitableness of the entire farm business.

Procedure.—These investigations are conducted by making a careful analysis of the entire farm business on a large number of dairy farms, also of determining the cost of producing the dairy products on each of the farms considered. This not only permits an accurate determination of the cost of the dairy product but gives the true relation of its production to the profitableness of the entire farm business.

Location.—Headquarters, Washington, D. C.

Date begun.—1906.

Results.—Carefully kept cost-accounting records have been obtained from dairy farmers over a long period of years. These records, dealing with all the factors involved in the cost of producing milk, have been compiled and the results submitted for publication in the Department Bulletin series under the title "The Cost of Producing Milk," this being based on records obtained from dairy farms located in Wisconsin, Michigan, Pennsylvania, and North Carolina. Analytical studies have been made on over 1,000 dairy farms in Pennsylvania, Michigan, and Wisconsin, with the view of making a much more comprehensive study of this problem.

Assignment.—C. M. Bennett, M. O. Cooper, H. M. Dixon.

Proposed expenditures, 1916-17.—\$2,600.

Total, Live-Stock Economics, \$19,400, including \$2,720 statutory.

HISTORY AND DISTRIBUTION OF FARM ENTERPRISES.**History and Distribution of Farm Enterprises:**

Object.—To determine the geographic factors which control the distribution of the various crops and types of live stock in this country. This project involves a study of the history of farming with the view of gaining further insight into the forces that determine the distribution of agricultural enterprises.

Procedure.—Large masses of geographic and statistical data are compiled, the work being conducted largely in cooperation with the various bureaus of this department and with the Bureau of Census in the Department of Commerce.

Cooperation.—Various bureaus of this department, the Census Bureau, and the Wisconsin Experiment Station.

Location.—Washington, D. C.

Date begun.—1912.

Results.—Substantial progress has been made in the preparation of maps, charts, etc., showing the distribution of various crops and types of live stock in this country, for the "Atlas of American Agriculture." In connection with these studies a supplementary atlas dealing with the agriculture of the world has been prepared and is ready for publication. An immense amount of data collected by various governmental agencies is being studied with reference to its correlation with agricultural practices and in the light of farm-management experience. An article entitled "A Graphic Summary of American Agriculture" was published in the Department Yearbook for 1915.

Assignment.—O. E. Baker, E. A. Goldenweiser.

Proposed expenditures, 1916-17.—\$32,051, including \$13,520 statutory.

FARM-MANAGEMENT SURVEYS.

Analysis of the Farm Business:

Object.—To determine the farmer's investment, receipts, expenditures, and net income from the farm business and the important factors which largely control this income. It includes studies of the relation of profit to tenure, the size of the business, and the diversification and efficiency of the various farm enterprises.

Procedure.—Complete financial analyses are made of a large number of farms in specific areas. These individual farm analyses are summarized and classified in various ways to determine what each farmer receives for his year's work and to learn the effect on profits received of such factors as yield of crops, use of labor and machinery, and general efficiency of the farm business.

Cooperation.—States Relations Service and various State colleges and experiment stations.

Location.—Chester County, Pa., Lenawee County, Mich., Clinton County, Ind., Utah County, Utah, Dane County, Wis., Sumter County, Ga., Washington County, Ohio, and various other areas in the several States.

Date begun.—1906.

Results.—Business analyses have been made of several thousand farms in the areas mentioned. The determination of certain factors which underlie the cause of success or failure in farming has given a much clearer understanding of the problems of farm organization and of the relation between magnitude of the farm business, crop yields, and efficiency of live stock to the farmer's income. A complete analysis of over 500 farms in an old and well-developed district in Chester County, Pa., was made, and the results published in Department Bulletin 341. Important data have also been collected and compiled dealing with the question of how present farm owners are acquiring land in regions of high land values. Similar studies have been made in many other districts during the past few years, some of the results of which are published in B. P. I. Circular 75 and Department Bulletins 41 and 117.

Assignment.—H. M. Dixon, H. W. Hawthorne.

Proposed expenditures, 1916-17.—\$16,920.

Cost of the Farmer's Living:

Object.—To determine the cost of the farmer's living and what the farm contributes directly in the form of garden products, milk, butter, eggs, etc.; to find the relation and value of these products to the farmer's income and to the welfare of the farm family.

Procedure.—Complete records giving the amount and value of the items constituting the important features of the farmer's living are obtained from several hundred farmers in specified areas. These individual records are summarized and classified to bring out the factors desired.

Location.—Washington, D. C. (headquarters) and selected areas in the various States.

Date begun.—1914.

Results.—Many valuable data have been obtained on the cost of the farmer's living and what the farm contributes directly in the form of garden products, milk, butter, eggs, etc. Farmers' Bulletin 635, "What the Farm Contributes Directly toward the Farmer's Living," has been published, and another manuscript entitled "Value to Farm Families of Food, Fuel, and Use of House" is in press.

Assignment.—W. C. Funk.

Proposed expenditures, 1916-17.—\$3,620.

Farm Tenantry:

Object.—To determine the prevailing systems of farm tenancy and the underlying principles of tenant farming; to devise lease contracts that will secure an equitable division of the farm income and which will tend to maintain a system of farming that will not prove detrimental to the development of agriculture in those areas.

Procedure.—Complete financial analyses of a large number of tenant farms in specific areas are made. These individual farm analyses are summarized to determine what the tenant and landlord receive for their investment and their year's work.

Cooperation.—States Relations Service and various State colleges and experiment stations.

Farm Tenantry—Continued.

Location.—Washington, D. C. (headquarters), and various areas in the several States.

Date begun.—1906.

Results.—Analyses have been made of several hundred farms in all the agricultural districts where tenant farming is of primary importance. Data have been obtained in respect to the underlying principles of these contracts and the effect of the various features of each system of tenancy upon the income received by tenant and landlord. Department Bulletin 337, "A Study of a Tenant System of Farming in the Yazoo-Mississippi Valley," has been published, and a manuscript entitled "Systems of Renting Truck Farms in Southwestern New Jersey" is in press.

Assignment.—E. A. Boeger, H. A. Turner.

Proposed expenditures, 1916-17.—\$5,760.

Total, Farm-Management Surveys, \$26,300, including \$6,000 statutory.

FARM EQUIPMENT.**Farm Equipment:**

Object.—Determination of the economics of the character, cost, and adequacy of equipment in machinery, implements, work horses, etc., on farms of different types and sizes in different sections of the country.

Procedure.—Data are collected dealing with the farmer's experience in regard to the various items of farm equipment. These field results are compiled and reports prepared dealing with the cost, character, and use of the various types with reference to the profitable operation of the farm.

Cooperation.—Bureau of Plant Industry.

Location.—General.

Date begun.—1906.

Results.—(1) Three bulletins dealing with economic features of farm equipment were issued during the past year, as follows: Department Bulletin 321, "Cost of Fencing Farms in the North Central States"; Department Bulletin 338, "Machinery Costs of Farm Operations in Western New York"; and Farmers' Bulletin 719, "An Economic Study of the Tractor in the Corn Belt"; and the manuscript for a farmers' bulletin entitled "Use of Milking Machines as Affecting the Organization of Dairy Farms" is in press. Efficiency studies of the factors affecting the cost of greenhouse heating and equipment have been continued, and manuscripts have been prepared covering the results. The most apparent factor is the necessity of keeping the houses in good repair. The data so far obtained show a fuel cost of 30 per cent below the average for those in poor condition; yet 31 per cent of the establishments have houses in poor repair. This factor alone represents a total annual loss of more than \$1,000,000 to greenhouse owners. Studies of small farm tools and handy devices, also certain investigations on the cost of harvesting wheat, have been undertaken. The study of the economic value of farm tractors in various types of farming in different sections of the country has been continued.

(2) Prior to the past year the work in farm-equipment investigations followed the same lines as above outlined, and some of the results are contained in the following publications: Bureau of Plant Industry Bulletin 170, "Tractor Plowing"; B. P. I. Bulletin 212, "Study of Farm Equipment in Ohio"; B. P. I. Circular 44, "Minor Articles of Farm Equipment"; Department Bulletin 3, "A Normal Day's Work for Various Farm Operations"; and Department Bulletin 174, "Farm Experience with the Tractor."

Assignment.—A. P. Yerkes, H. N. Humphrey, L. L. Corbett, Lillian M. Church.

Proposed expenditures, 1916-17.—\$12,190, including \$1,400 statutory.

FARM ACCOUNTS.**Farm Accounts:**

Object.—To investigate and determine practical methods of farm bookkeeping and accounting.

Procedure.—Studies are made of various existing systems of bookkeeping as worked out by farmers in different parts of the country and by other individuals interested in that line of research. Records are also kept of a number of farms to test the practicability of different methods.

Cooperation.—New York, Wisconsin, and Minnesota experiment stations.

Location.—Washington, D. C., and various farms in different parts of the country.

Date begun.—1906.

Farm Accounts—Continued.

Results.—Additional information regarding the practicability of certain systems of farm accounting and analyses have been compiled, and two manuscripts dealing with this study are in course of preparation. From an extensive review of the various systems of farm bookkeeping and accounting used by farmers and others, the most practical methods for keeping farm records have been selected. Some of these are outlined and described in Farmers' Bulletins 511, 572, and 661.

Assignment.—C. M. Bennett, J. S. Ball.

Proposed expenditures, 1916-17.—\$9,731.

Total, Investigations in Farm Economics, \$129,192, including \$25,840 statutory.

[Research.]

APPLICATION OF FARM ECONOMICS TO FARM PRACTICE.**Farm Organization in the Northeastern Region:**

Object.—To interpret the economic conditions prevailing in this agricultural region and to correlate data collected by the various agencies of the department, the State institutions, and others and utilize such data to develop systems of farm organization and operation adapted to the various types and sizes of farms prevailing, or that should prevail, in this section.

Procedure.—The careful analytical studies of the farm business made by the various departmental agencies and by the State colleges of agriculture are interpreted and applied in the development of systems of farming suited to this particular area.

Cooperation.—States Relations Service, the various State colleges and experiment stations, and individual farmers.

Location.—Washington, D. C. (headquarters), and the northeastern section of the United States.

Date begun.—1913.

Results.—During the summer and fall of 1914 a study was made of nine groups of farms covering, in a broad way, the southern half of the New England States. Through cooperation and exchange of records with demonstration agents, over 900 complete farm analyses were made. A similar survey has been made in the northern part of New England, including as many farm analyses. Coupled with these complete statements of the farmer's business, enterprise records have been obtained, giving the time of operating and the labor required for each important crop in these districts. These data are being used to develop and work out more profitable systems of farms organization in the Northeastern States, and several manuscripts are being prepared for publication. In Gloucester County, N. J., a region where truck farming is of primary importance, about 350 farms analyses records have been taken for two successive years. This study will be repeated another year before publishing results.

Assignment.—J. S. Cates, G. A. Billings, F. H. Branch, L. G. Howell.

Proposed expenditures, 1916-17.—\$11,395.

Farm Organization in the Northern Dairy Region:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Cooperation.—Same as preceding project.

Location.—Washington, D. C. (headquarters), and northern dairy region.

Date begun.—1913.

Results.—Data giving a business analysis of over 800 farms located in the northern cut-over districts have been compiled and prepared for publication in a bulletin entitled "Agricultural Development of the Northern Cut-Over District of Michigan, Wisconsin, and Minnesota." In connection with these studies substantial progress has been made on several systems of farming which seem to be especially well adapted to the climatic, soil, and economic conditions prevailing in these northern cut-over areas. Each of these will be published as soon as the details have been well worked out. Special attention has been given to the management of sandy-land farms in northern Indiana and southern Michigan, and a manuscript entitled "Management of Sandy-Land Farms in Northern Indiana and Southern Michigan" is now in press. A manuscript entitled "Influence of Age on the Value of Dairy Cows and Farm Work Horses" has been submitted for publication.

Assignment.—Leaders to be assigned.

Proposed expenditures, 1916-17.—\$11,135.

Farm Organization in the Middle-Atlantic and Appalachian-Mountain Region:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Cooperation.—Same as preceding project.

Location.—Washington, D. C. (headquarters), and the Middle Atlantic and Appalachian Mountains region.

Date begun.—1913.

Results.—Substantial progress has been made in working out systems of farming adapted to farms in these States. Manuscripts have been prepared, entitled "An Agricultural Survey of Preston County, West Virginia," and "A Study of Farm Management in the Bluegrass Region of Kentucky." Some bulletins which have been published are: Department Bulletin 29, "Crew Work, Costs, and Returns in Commercial Orchardling in West Virginia," and Farmers' Bulletin 546, "How to Manage a Corn Crop in Kentucky and West Virginia." A bulletin entitled "An Agricultural Survey of Brooks County, West Virginia," has been published in cooperation with the West Virginia Experiment Station.

Assignment.—H. A. Miller, A. J. Dadisman.

Proposed expenditures, 1916-17.—\$14,336.

Farm Organization in the Cotton Belt:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Cooperation.—Same as preceding project.

Location.—Washington, D. C. (headquarters), and cotton belt.

Date begun.—1913.

Results.—Extensive studies embodying an analysis of the entire farm business and the cost of each crop and kind of live stock have been made on several hundred farms in representative areas of the cotton-growing States. The data collected during these field investigations have been compiled, and the results are in manuscript form ready for publication. Some of the more important areas which have been given special attention are: Ellis County, Tex., north-western Louisiana, Hope and Conway Counties, Ark., Brooks County, Ga., Anderson County, S. C., and Catawba County, N. C. The following are some of the publications dealing with the more important features of the agriculture in these States: Farmers' Bulletins—279, "Method of Eradicating Johnson Grass"; 361, "A Profitable Cotton Farm"; 441, "Lespedeza or Japan Clover"; 519, "An Example of Intensive Farming in the Cotton Belt," and 529, "Vetch Growing in the South Atlantic States."

Assignment.—C. L. Goodrich.

Proposed expenditures, 1916-17.—\$16,295.

Farm Organization in the Ohio River Valley and the Ozarks:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Cooperation.—Same as preceding project.

Location.—Washington, D. C. (headquarters), Ohio River Valley, and the Ozarks.

Date begun.—1913.

Results.—Only preliminary studies have been made in this region, with the view of instituting more careful investigations in regard to the most profitable systems of farming for these areas.

Assignment.—J. A. Drake.

Proposed expenditures, 1916-17.—\$8,355.

Farm Organization in the Corn Belt:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Cooperation.—Same as preceding project.

Location.—Washington, D. C. (headquarters), and the corn belt.

Date begun.—1913.

Results.—Substantial progress has been made in the study and development of systems of farming which will permit of a more efficient use of labor on farms in the corn-belt States. These systems aim to eliminate the difficulties arising at rush seasons by means of harvesting some of the crops to live stock, thereby materially assisting in maintaining the productivity of the soil and at the same time providing a profitable farm business. Farmers' Bulletin 614, "A Corn-Belt

Farm Organization in the Corn Belt—Continued.

Farming System Which Saves Harvest Labor by Hogging Down Crops," has been published. Several other systems of farm organization have been developed, but as yet the results are not ready for publication.

Assignment.—A. G. Smith.

Proposed expenditures, 1916-17.—\$12,275.

Farm Organization in the Middle West or Plains Region:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Cooperation.—Same as preceding project.

Location.—Washington, D. C. (headquarters), and Middle West or Plains region.

Date begun.—1913.

Results.—Farm organization work in this district has not yet been fully organized, and only preliminary results are available.

Assignment.—J. H. Arnold.

Proposed expenditures, 1916-17.—\$9,265.

Farm Organization in the Rocky Mountain and Pacific Region:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Cooperation.—Same as preceding project.

Location.—Washington, D. C. (headquarters), and the Rocky Mountain and Pacific region.

Date begun.—1913.

Results.—The results of a study begun last year of the problems of farm organization in the Palouse country in Washington, the irrigated valleys of Arizona, and the Salt Lake Valley in Utah, and the results of similar studies in Marion and Folk Counties, Oreg., for the past three years have been analyzed, tabulated, and prepared for publication. Similar work has been carried out on the Billings-Humphrey project in Montana. Systems of farming with special reference to bean growing in northern Washington and Idaho have been worked out, also those involving forage crops in western Oregon and western Washington; and farm practices in the management of alfalfa pastures in the Salt River Valley in Arizona have been carefully studied. Over 1,500 business analyses of farms in various districts have been made, and these are being used as a basis for the development of various systems of farming adapted to specific regions in those States. The following are some of the publications dealing with agricultural practices in those districts: Farmers' Bulletins—294, "Farm Practice in the Columbia Basin Uplands"; 599, "Pasture and Grain Crops for Hogs in the Pacific Northwest"; and 561, "Bean Growing in Eastern Washington and Oregon and Northern Idaho."

Assignment.—D. A. Brodie, Byron Hunter, S. O. Jayne, L. W. Fluharty.

Proposed expenditures, 1916-17.—\$17,395.

Special Agricultural Problems in the Rocky Mountain and Pacific Region:

Object.—In view of the widely diversified agricultural practices existing in these States and of the instability of the agriculture which is being developed in many of the newly settled areas, special investigations of specific problems are necessary. This project has for its object the prosecution of these particular problems.

Procedure.—Careful studies are made of all the economic features which may have a bearing on the development of agriculture in these new areas, with special reference to the soil, climate, and topographic features which may have a bearing upon the profitability of farming in that area.

Cooperation.—States Relations Service and agricultural agencies in the various Western States.

Location.—Washington, D. C. (headquarters), and the Rocky Mountain and Pacific region.

Date begun.—1915.

Results.—An immense amount of data has been collected on problems relating to the development of irrigated areas and to the economics of the ranching business with a view to the publication of these results in the near future.

Assignment.—R. W. Clothier, Levi Chubbuck, E. O. Wooton.

Proposed expenditures, 1916-17.—\$13,375.

Total, Application of Farm Economics to Farm Practice, \$113,826, including \$7,600 statutory.

[Research.]

CLEARING AND UTILIZATION OF LOGGED-OFF LANDS.**Clearing and Utilization of Logged-Off Lands:**

Object.—To determine the methods used in the various timbered sections of the United States in clearing stumps from land from which the timber has been taken and putting such land in shape for agricultural purposes, to ascertain the cost of these various methods, and to determine the most practicable methods to be used under various conditions.

Procedure.—Studies of methods and costs of burning and removing stumps from cut-over lands are made, including methods employed by settlers and by companies developing large tracts of land with expensive equipment specially designed for the purpose of clearing off such types of land. Attention is also given to the economic conditions which render the clearing of land practicable.

Location.—Cut-over sections of the United States.

Date begun.—1908.

Results.—In addition to the study of methods and cost of clearing logged-off lands as reported last year, a study of the utilization of farms that have been cleared or are being cleared was made. This includes an investigation of the methods used by the farmers in clearing land, the estimated costs of such methods, the systems of farming which are developing, and the means by which the farmer and his family make their living while the land is being cleared.

Assignment.—Harry Thompson.

Proposed expenditures, 1916-17.—\$5,000.

WEATHER BUREAU.

GENERAL ADMINISTRATION.

General Administration:

Object.—To direct the policy and business affairs of the bureau and to supervise its scientific activities.

Location.—Washington, D. C.

Date begun.—1891 (date of transfer of meteorological work to the Department of Agriculture; meteorological work began November 1, 1870, under War Department, Signal Corps, U. S. A.).

Assignment.—C. F. Marvin, chief; C. C. Clark, assistant chief; E. B. Calvert, chief clerk.

Proposed expenditures, 1916-17.—\$75,080, including \$43,490 statutory (service, \$70,500; research, \$4,580).

[Service.]

COLLECTION AND DISSEMINATION OF METEOROLOGICAL, CLIMATOLOGICAL, AND MARINE INFORMATION.

Forecasts and Warnings:

Object.—To take, record, encipher, telegraph, compile, and tabulate regular meteorological observations, and to care for and maintain the instrumental equipment therefor; to issue weather forecasts twice daily, including frost, cold-wave, storm, and small-craft warnings at the district forecast centers for their respective districts as follows: Washington, D. C., district: Maine, New Hampshire, Vermont, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, West Virginia, Kentucky, Tennessee, Ohio, Indiana, Michigan, and upper and lower Lakes; Chicago, Ill., district: Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska, South Dakota, North Dakota, Montana, and Wyoming; Denver, Colo., district: Colorado, New Mexico, Arizona, and Utah; San Francisco, Cal., district: California and Nevada; Portland, Oreg., district: Washington, Oregon, and Idaho; New Orleans, La., district: Louisiana, Arkansas, Texas, and Oklahoma; to issue special wind forecasts in connection with forest-fire prevention, shippers' forecasts, and other special forecasts in the interests of manufacturing, commerce, and agriculture, at selected stations; to prepare daily weather forecasts at selected stations for their immediate vicinity; also to print the same or issue by other means, and disseminate by maps, bulletins, telegraph, and telephone messages; to prepare reports for the press of weather synopses, forecasts, and full and complete information concerning the current local weather conditions in all their phases.

Location.—Washington, D. C., Chicago, Ill., Portland, Oreg., San Francisco, Cal., Denver, Colo., New Orleans, La., and 195 other stations (designated by letter "A" under table "Distribution of work by stations").

Date begun.—1891.

Assignment.—H. E. Williams, E. H. Bowie, H. C. Frankenfield, A. J. Henry, H. J. Cox, E. A. Beals, G. H. Wilson, F. H. Brandenburg, I. M. Cline.

Proposed expenditures, 1916-17.—\$980,000.

River and Flood Work:

Object.—To develop and improve methods of river and flood forecasting; to establish and maintain river-gauging stations and substations which observe and report rainfall, river stages, and like conditions; to disseminate flood information to the public, especially to the parties and interests most directly benefited thereby.

Location.—Washington, D. C., and 59 other stations (designated by letter "B" under table "Distribution of work by stations").

Date begun.—1891.

Assignment.—A. J. Henry and officials in charge of the various river districts.

Proposed expenditures, 1916-17.—\$171,600.

Climatological Work:

Object.—To collect, compile, chart, and discuss climatological data of the United States; to print and promptly disseminate the information to the public, to commercial exchanges, and to all parties and organizations interested in or benefited by the service that can be promptly reached by the usual means of communication available; to collect, compile, and furnish to the Hydrographic Office for publication marine meteorological and climatological data.

Cooperation.—Hydrographic Office, Navy Department.

Location.—Washington, D. C., and the various section centers and special crop-reporting centers (designated by letter "C" under table "Distribution of work by stations").

Date begun.—1891.

Assignment.—P. C. Day and officials in charge of section centers and special crop-reporting centers.

Proposed expenditures, 1916-17.—\$350,080.

Agricultural Meteorology:

Object.—To collect and disseminate information relative to the effect of weather and climate on crops and during the crop season, from April 16, to October 31; to collect daily telegraphic reports from selected substations, reporting in the interests of cotton, corn, wheat, sugar, rice, tobacco, fruit, and other standard crops, for publication and dissemination to the public; to issue weekly summaries of weather and crop conditions to commercial exchanges and to all parties and organizations interested in or benefited by the service that can be promptly reached by the usual means of communication available.

Location.—Washington, D. C., and the various special crop-reporting centers (designated by letter "D" under table "Distribution of work by stations").

Date begun.—1891.

Assignment.—J. Warren Smith and officials in charge of special crop-reporting centers.

Proposed expenditures, 1916-17.—\$80,000.

Vessel Reporting:

Object.—To collect and transmit marine intelligence for the benefit of commerce and navigation.

Location.—Cape Henry, Va., Port Angeles, Wash., and other stations (designated by letter "F" under table "Distribution of work by stations").

Date begun.—1891.

Assignment.—J. F. Newsom, L. G. Sutton.

Proposed expenditures, 1916-17.—\$8,000.

Total, Collection and Dissemination of Meteorological, Climatological, and Marine Information, \$1,589,680, including \$279,250 statutory.

[Research.]

INVESTIGATION AND RESEARCH.**Improvement of Instrumental Equipment:**

Object.—To select, test, improve, and design instrumental apparatus for the scientific work of the bureau.

Location.—Washington, D. C.

Date begun.—1891.

Results.—(1) During 1916: The storm-warning stations on the Great Lakes have been equipped with a three-lantern system for night displays of storm warnings (work being about 50 per cent completed); new snow sampler designed, combining accuracy and portability; new seismograph developed.

(2) Prior to 1916: Equipment designed includes the Marvin precision barograph, Marvin seismograph, and the Marvin pyrliometer, kites and meteorographs for the exploration of the upper air, and evaporation and snow measuring instruments. Constants of the psychrometric formulæ have been determined. A series of circulars of instructions have been published for (a) obtaining and tabulating records from recording instruments, (b) cooperative observers, (c) installation and maintenance of wind measuring and recording apparatus, (d) measurement of precipitation, (e) barometers and the measurement of atmospheric pressure, (f) care and management of electrical sunshine records, (g) aerial observers, and (h) installation and operation of class "A" evaporation stations. Weather Bureau psychrometric tables have been published.

Assignment.—B. C. Kadel.

Proposed expenditures, 1916-17.—\$2,500.

Investigations of the Problems of Forecasting:

Object.—To improve the accuracy of forecasts and to formulate rules and enunciate principles in connection therewith.

Location.—Washington, D. C., and Chicago, Ill.

Date begun.—1891.

Results.—(1) During 1916: The text of a treatise on "Weather Forecasting in the United States" has been completed and is now in the hands of the printer. A paper, with numerous charts, showing the monthly distribution of precipitation over the United States for nine recognized types of low-pressure systems has been completed. A study of the relation of pressure changes to the area of high and low barometer appears in the Monthly Weather Review for March, 1916. The conclusions reached in this paper were to the effect that pressure changes in any given interval follow as a result of the movements of and changes in pressure levels in highs and lows, and are not to be considered as independent phenomena, as has been regarded by a number of writers. A bulletin entitled "Types of Highs and Their Average 24-Hour Movements in the United States" is being prepared for publication. Improvements have been made in the methods of charting pressure changes and the character, amount, and direction of movement of clouds on the auxiliary forecast charts, bringing these data into direct relation with the cyclones and anticyclones. The improved charts give promise of being valuable aids in forecasting.

(2) Prior to 1916: Improvements have been made from time to time in the methods of forecasting weather conditions, resulting in increased accuracy and range.

Assignment.—A. J. Henry, H. C. Frankenfield, E. H. Bowie, H. J. Cox.

Proposed expenditures, 1916-17.—\$4,500.

River and Flood Investigations:

Object.—To improve methods of flood forecasting.

Location.—Washington, D. C., and other river centers.

Date begun.—1891.

Results.—(1) During 1916: Extension of time of issuing warnings in advance of floods.

(2) Prior to 1916: The relation between rainfalls of varying intensities and the stages of water reached in the rivers has been determined for certain rivers of South Carolina. Flood and precipitation data for portions of the Ohio basin have been compiled.

Assignment.—A. J. Henry.

Proposed expenditures, 1916-17.—\$3,550.

Investigations in Climatology:

Object.—To determine more fully the climate of the entire United States, including the insular possessions.

Cooperation.—Several bureaus of the department, other departments, State agricultural and meteorological organizations, and colleges.

Location.—Washington, D. C.

Date begun.—1891.

Results.—(1) During 1916: A large amount of data has been prepared for use in a forthcoming Atlas of American Agriculture, embracing material for more than 100 separate charts, showing the principal climatic facts considered of value to students investigating the relation between plant growth and climatic conditions for all parts of the country, necessitating the reduction of the various precipitation station records for the entire United States, made during the past 20 years, to a uniform basis for the same period. That is, all incomplete records during that time have been reduced to the 20-year period by the recognized system adopted for such reductions. The result has been the accumulation of the records of nearly 4,000 stations and their reduction to a uniform basic period of time, a task of greater magnitude than ever before attempted by the bureau along similar lines. The final results are now being spread upon appropriate charts and will form a valuable asset to our knowledge of the distribution of the rainfall of the country.

Relative humidity data for the United States have been compiled, which it is expected to publish shortly as a supplement to the Weather Review. The data collected present practically every phase of the distribution of atmospheric moisture over the different parts of the country and should form a valuable addition to the literature on that subject.

Investigations in Climatology—Continued.

A discussion of the weather over the North Atlantic Ocean, in connection with the marine work, is published regularly in the Monthly Weather Review.

(2) Prior to 1916: The National Weather and Crop Bulletin and the Snow and Ice Bulletin have been issued. An extensive climatology of the United States, known as Bulletin W of the bureau, and made up of 106 separate parts embracing the entire country, has been published. These separates have been invaluable as a means of facilitating compliance with the numerous requests constantly being made on the bureau for climatic information, by affording complete data in convenient and comprehensive form for every section of the country.

The bureau has published various climatic charts and bulletins for the country as a whole, which largely supplement Bulletin W by portraying in graphic form the distribution of the various climatic elements for the different portions of the country.

Assignment.—P. C. Day.

Proposed expenditures, 1916-17.—\$5,830.

Aerological Investigations:

Object.—To study upper-air conditions by means of kites and balloons for the purpose of fixing the general meteorological data in the whole atmospheric mass.

Cooperation.—War Department.

Location.—Washington, D. C., and Drexel, Nebr.

Date begun.—1914.

Results.—(1) During 1916: Installation at Drexel aerological station completed, and free-air observation begun there in October, 1915.

(2) Prior to 1916: The reduction and publication of the five years' series of daily free-air observations at Mount Weather observatory; six series of sounding balloon ascensions, 116 observations altogether, made at middle west and western points; observations of mountain and valley conditions in the vicinity of Mount Weather and of Lone Pine, Cal.; and one year's free-air observations mostly devoted to the study of the diurnal system of convection.

Assignment.—W. R. Blair, W. R. Gregg, B. J. Sherry.

Proposed expenditures, 1916-17.—\$13,000.

Solar Radiation Investigations:

Object.—To determine the insolation received in heat units on a horizontal surface from the sun and sky under all sky conditions; to determine the radiation received on a normal surface in gram calories; to establish normals for insolation; to investigate the relation between polarization and insolation on clear days; to determine the effect of atmospheric conditions on nocturnal radiation; and to measure the insolation received through ray filters under different conditions.

Cooperation.—Bureau of Standards.

Location.—Washington, D. C., Madison, Wis., Santa Fe, N. Mex., and Lincoln, Nebr.

Date begun.—1913.

Results.—(1) During 1916: Measurements have shown direct solar radiation during the year 1916 to be above its average intensity.

(2) Prior to 1916: Summaries showing diurnal and annual variation in solar radiation and daily and monthly departures from normal values have been published.

Assignment.—H. H. Kimball, E. R. Miller, C. E. Linney, C. T. Hilmers.

Proposed expenditures, 1916-17.—\$8,000.

An Empirical Determination of the Relative Values of Evaporation in the United States:

Object.—Primary: To determine under standard conditions of exposure the relative values of evaporation in various portions of the United States. Secondary: To establish the relation between the evaporation under the above standard conditions and the climatological factors that combine to bring it about.

Cooperation.—Reclamation Service, Geological Survey, Forest Service, Bureau of Plant Industry, Office of Public Roads and Rural Engineering, State organizations, and private parties.

Location.—Washington, D. C., and Wagon Wheel Gap, Colo.

Date begun.—1915.

Assignment.—B. C. Kadel, Cleveland Abbe, jr., Alonzo A. Justice.

Proposed expenditures, 1916-17.—\$5,320.

Meteorological Investigations:

Object.—To determine the nature of meteorological phenomena, and the laws of their actions.

Location.—Washington, D. C.

Date begun.—1913.

Results.—(1) During 1916: The discovery of the physical basis of Egnell's law, or explanation, why the wind velocity increases with altitude at approximately the same rate that the density decreases. A paper entitled "General Circulation of the Atmosphere" has been prepared for publication as Chapter II of the Forecast Manual.

(2) Prior to 1916: The reason why the temperature of the atmosphere changes comparatively little with elevation beyond the level of 10 to 11 kilometers has been explained. It has been discovered from balloon records that, generally, the troposphere (atmosphere up to about 11 kilometers) is warmer in anticyclonic than in cyclonic regions, and that the stratosphere (atmosphere beyond about 11 kilometers) is colder in anticyclonic than in cyclonic regions. These results were, in part, quite unexpected, but have been abundantly confirmed by other students of this problem. The reason for the location of the permanent and semipermanent ocean highs, 5 in number, and lows, 2 in number, at their respective places has been explained. It has also been explained why clouds occur far more frequently at certain levels (two) than at any others. A theoretical and historical discussion of the effect of volcanic dust on the temperature of the atmosphere, with a number of new and interesting conclusions, has been presented; also a discussion, involving much that is new, of the thunderstorm and its phenomena.

Assignment.—W. J. Humphreys.

Proposed expenditures, 1916-17.—\$1,800.

Seismological Investigations:

Object.—To map the United States according to seismological activity and locate geological faults; to study in detail earthquake vibrations and draw inferences therefrom in regard, on the one hand, to the scientifically important problem of the structure of the earth and, on the other, to the practical question of types of building best adapted to withstand seismic shocks.

Cooperation.—Geological Survey.

Location.—Washington, D. C., Northfield, Vt., and San Francisco, Cal.

Date begun.—1914.

Results.—A preliminary seismic map of the United States, based on the 150 earthquakes felt in this country during the calendar year 1915, has been constructed.

Assignment.—W. J. Humphreys.

Proposed expenditures, 1916-17.—\$3,000.

Investigations in Agricultural Meteorology:

Object.—To investigate the effect of weather and climate upon the growth and yield of crops; to investigate the protection of crops and orchards from frost.

Location.—Washington, D. C.

Date begun.—1916.

Assignment.—J. Warren Smith.

Proposed expenditures, 1916-17.—\$11,500.

Ice-Storm and Sleet Investigations:

Object.—To enable the Weather Bureau to meet the demands from telegraph and telephone companies, electric-power transmission companies, horticulturists, students, etc., for information relating to ice storm and sleet; to improve and extend the issue of forecasts and warnings of the approach of such storms; and to collect and publish statistical data thereon showing distribution, frequency, and severity of ice storms, including details concerning the accompanying winds and other allied weather conditions, the thickness, weight, and damaging effects of ice coatings to vegetation, overhead-line construction, etc.

Cooperation.—Bureau of Standards, and private firms, corporations, and individuals.

Location.—Washington, D. C.

Date begun.—1916.

Assignment.—W. J. Humphreys, H. C. Frankenfield.

Proposed expenditures, 1916-17.—\$1,000.

Total, Investigation and Research, \$60,000, including \$13,320 statutory.

[Extension.]

EDUCATIONAL WORK.

Educational Work:

Object.—To give instruction in meteorology by means of lectures and special courses, often according to definite schemes of cooperation between universities, colleges, and other educational institutions, and the local representatives of the Weather Bureau.

Cooperation.—Shown under table "Distribution of work by stations."

Location.—Shown by letter "I" under table "Distribution of work by stations."

Date begun.—Shown for each station in table "Distribution of work by stations."

Assignment.—Shown under table "Distribution of work by stations."

Proposed expenditures, 1916-17.—None; facilities furnished by universities, colleges, and other educational institutions.

DISTRIBUTION OF WORK BY STATIONS.

Location.	Character of work. ¹	Cooperation.	Date begun.	Assignment.	Proposed expenditures, 1916-17.
Abilene, Tex.	A. ....	.....	1885	William H. Green....	\$2,300
Albany, N. Y.	A, B. ....	.....	1873	George T. Todd....	7,100
Alpena, Mich.	A, B, E. ....	.....	1872	Frank Jermin....	4,200
Amarillo, Tex.	A. ....	.....	1892	Thomas J. Considine..	3,500
Anniston, Ala.	A. ....	.....	1905	Robert H. Dean....	1,700
Asheville, N. C.	A. ....	.....	1902	Thomas R. Taylor....	3,500
Atlanta, Ga. (section center).	A, B, C, D. ....	.....	1878	Charles F. von Hermann.	12,600
Atlantic City, N. J.	A. ....	.....	1873	Levi A. Judkins....	2,800
Augusta, Ga.	A, B, C, D. ....	.....	1870	Eugene D. Emigh....	5,920
Baker, Oreg.	A. ....	.....	1911	William D. Maxwell....	1,420
Baltimore, Md. (section center).	A, C, D, I.	Johns Hopkins University.	1871	Oliver L. Fassig....	7,940
Bentonville, Ark.	A. ....	.....	1906	Orin Parker....	1,500
Binghamton, N. Y.	A. ....	.....	1896	John R. Weeks....	5,090
Birmingham, Ala.	A. ....	.....	1903	Edgar C. Horton....	4,790
Bismarck, N. Dak. (section center).	A, B, C, D.	University of North Dakota.	1874	Orris W. Roberts....	6,140
Block Island, R. I.	A, E. ....	.....	1880	George W. Eddey....	2,050
Boise, Idaho (section center).	A, C, D, I.	Forest Service, Reclamation Service.	1898	Edward L. Wells....	7,900
Boston, Mass. (section center).	A, C, D, I.	Blue Hill Observatory.	1870	John W. Smith....	22,800
Buffalo, N. Y.	A, I.	Canisius College.	1870	David Cuthbertson...	13,580
Burlington, Vt.	A, I.	University of Vermont.	1906	John K. Hooper....	4,600
Cairo, Ill.	A, B. ....	.....	1871	Robert T. Lindley....	5,200
Canton, N. Y.	A. ....	.....	1906	John S. Hazen....	2,600
Cape Henry, Va.	A, E, F. ....	.....	1873	John F. Newsom....	8,880
Charles City, Iowa.	A. ....	.....	1904	Hal P. Hardin....	2,150
Charleston, S. C.	A, B, C, D. ....	.....	1871	James H. Scott....	7,800
Charlotte, N. C.	A. ....	.....	1878	Ora O. Atto....	3,400
Chattanooga, Tenn.	A, B. ....	.....	1879	Lewis M. Pindell....	8,600
Cheyenne, Wyo. (section center).	A, C, D, I.	Forest Service, Reclamation Service.	1870	Julius C. Jensen....	6,680
Chicago, Ill. (district forecast center).	A, C, D, E. ....	.....	1870	Henry J. Cox, Charles L. Mitchell.	44,710
Cincinnati, Ohio.	A, B. ....	.....	1870	William C. Devereaux.	16,880
Cleveland, Ohio.	A, I.	Case Scientific School.	1870	Eben H. Emery....	12,000
Columbia, Mo. (section center).	A, C, D, I.	University of Missouri.	1889	George Reeder....	5,400
Columbia, S. C. (section center).	A, B, C, D, I.	Charleston Museum...	1887	Richard H. Sullivan..	6,990
Columbus, Ohio (section center).	A, B, C, D, I.	Geological Survey, Hiram College, Oberlin College, Ohio State University, Ohio Experiment Station.	1878	William H. Alexander.	15,400
Concord, N. H.	A, B. ....	.....	1902	Elisha C. Vose....	3,660
Concordia, Kans.	A. ....	.....	1885	John W. Byram....	1,780
Corpus Christi, Tex.	A. ....	.....	1887	William F. Lehman...	3,880
Dallas, Tex.	A. ....	.....	1913	Joseph L. Cline....	5,890
Davenport, Iowa.	A, B. ....	.....	1871	Julius M. Sherier....	6,620
Dayton, Ohio.	A, B.	1911	R. Frank Young....	6,450
Del Rio, Tex.	A.	1905	William U. Simons...	1,850

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DISTRIBUTION OF WORK BY STATIONS—Continued.

Location.	Character of work. ¹	Cooperation.	Date begun.	Assignment.	Proposed expenditures, 1916-17.
Denver, Colo. (district forecast and section center).	A, B, C, D, I.	Forest Service, Reclamation Service, Colorado Agricultural College, and Colorado State College.	1871	Frédéric H. Brandenburg, Frederick W. Brist.	\$22,960
Des Moines, Iowa (section center).	A, B, C, D, I.	Iowa College and Experiment Station, Iowa State University, State Weather Service.	1878	George M. Chappel....	7,430
Detroit, Mich.....	A.....		1870	Norman B. Conger....	11,980
Devils Lake, N. Dak....	A.....		1904	Martin R. Hovde.....	2,180
Dodge City, Kans.....	A.....		1874	Harrison McP. Baldwin.	1,660
Drexel, Nebr.....	A, G.....	United States Army..	1914	Bertram J. Sherry....	12,970
Dubuque, Iowa.....	A, B.....		1873	James H. Spencer....	6,020
Duluth, Minn.....	A.....		1870	Herbert W. Richardson.	7,680
Eastport, Me.....	A.....		1873	William D. Fuller.....	2,340
Elkins, W. Va.....	A.....		1889	Harris A. Jones.....	2,790
El Paso, Tex.....	A.....		1878	Nathan D. Lane.....	3,890
Erie, Pa.....	A.....		1873	Harry O. Geren.....	6,530
Escanaba, Mich.....	A.....		1898	Harvey H. Spindler...	2,890
Eureka, Cal.....	A.....		1886	James Jones.....	2,300
Evansville, Ind.....	A, B.....		1897	Albert Brand.....	5,780
Fort Smith, Ark.....	A, B.....		1882	Leon J. Guthrie.....	5,160
Fort Wayne, Ind.....	A.....		1911	Patrick McDonough...	6,390
Fort Worth, Tex.....	A.....		1898	Dennis S. Landis.....	5,200
Fresno, Cal.....	A, B.....		1887	Walter E. Bonnett....	7,230
Galveston, Tex.....	A.....		1871	William P. Stewart....	5,600
Grand Haven, Mich....	A.....		1905	William J. Schnurbusch.	2,980
Grand Junction, Colo..	A.....		1899	Esek. S. Nichols.....	6,220
Grand Rapids, Mich. (section center).	A, B, C, D, I.	Michigan Experiment Station and University of Michigan.	1903	Charles F. Schneider..	8,240
Green Bay, Wis.....	A.....		1886	Frederick W. Conrad..	2,850
Hannibal, Mo.....	A, B.....		1892	Bion L. Waldron.....	3,890
Harrisburg, Pa.....	A, B.....		1888	Edward R. Demain....	5,060
Hartford, Conn.....	A, B.....		1904	William W. Neifert....	6,590
Hatteras, N. C.....	A, E.....		1874	Will L. Wyland.....	2,280
Havre, Mont.....	A, C, D, I.....	Reclamation Service, Forest Service.	1892	Charles W. Ling.....	1,920
Helena, Mont (section center).	A, C, D, I.....	Hawaii Experiment Station.	1880	H. F. Alps.....	9,880
Honolulu, Hawaii (section center).	A, C, D.....		1904	Andrew M. Hamrick..	6,800
Houghton, Mich.....	A.....		1900	Howard B. Cowdrick..	3,500
Houston, Tex. (section center).	A, B, C, D.....		1909	Bernard Bunnemeyer..	18,490
Huron, S. Dak. (section center).	A, C, I.....		1881	Montello E. Blystone..	5,850
Indianapolis, Ind. (section center).	A, B, C, D.....		1871	John H. Armington....	12,960
Iola, Kans.....	A, C.....		1905	Howard K. Holcomb....	2,190
Ithaca, N. Y. (section center).	A, C, D, I.....	New York Experiment Station, Cornell University, and Ranger School.	1887	Wilford M. Wilson....	7,020
Jacksonville, Fla. (section center).	A, C, D, I.....		1871	Alexander J. Mitchell..	15,970
Kalispell, Mont.....	A.....		1899	Harvey B. Dick.....	2,240
Kansas City, Mo.....	A, B, C.....		1888	Patrick Connor.....	12,890
Keokuk, Iowa.....	A, B.....		1871	Frederick C. Gosewisch	2,520
Key West, Fla.....	A, E, F.....		1870	Harry B. Boyer.....	9,050
Knoxville, Tenn.....	A, B.....		1871	John F. Voorhees.....	5,690
La Crosse, Wis.....	A, B.....		1872	Edwin C. Thompson....	5,290
Lander, Wyo.....	A.....		1891	McLin S. Collom.....	1,600
Lansing, Mich.....	A, I.....		1910	Dewey A. Seeley.....	5,180
Lewiston, Idaho.....	A.....		1900	Walter W. Thomas....	2,670
Lexington, Ky.....	A.....		1893	George B. Wurtz.....	4,490
Lincoln, Nebr. (section center).	A, C, D, H, I.	University of Nebraska.	1897	George A. Loveland...	8,510
Little Rock, Ark. (section center).	A, B, C, D, I.		1879	Harvey S. Cole.....	11,690

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DISTRIBUTION OF WORK BY STATIONS—Continued.

Location.	Character of work. ¹	Cooperation.	Date begun.	Assignment.	Proposed expenditures, 1916-17.
Los Angeles, Cal.....	A, I.....		1877	Ford A. Carpenter.....	\$12, 670
Louisville, Ky. (section center).....	A, B, C, D, I.....		1871	Ferdinand J. Walz.....	15, 180
Ludington, Mich.....	A.....		1912	Cyrus H. Eshleman.....	3, 300
Lynchburg, Va.....	A.....		1871	George N. Wilson.....	3, 780
Macon, Ga.....	A, B.....		1899	William A. Mitchell.....	4, 430
Madison, Wis.....	A, H, I.....	University of Wisconsin.	1904	Eric R. Miller.....	4, 590
Marquette, Mich.....	A.....		1871	Henry R. Patrick.....	3, 400
Memphis, Tenn.....	A, B, C.....		1871	Samuel C. Emery.....	8, 540
Meridian, Miss.....	A, B.....		1889	James H. Jaqua.....	5, 380
Miami, Fla.....	A.....		1911	Richard W. Gray.....	2, 850
Milwaukee, Wis. (section center).....	A, C, D, I.....		1870	Henry B. Hersey.....	13, 570
Minneapolis, Minn. (section center).....	A, B, C, D, I.....		1890	Ulysses G. Pursell.....	14, 960
Mobile, Ala.....	A, B, C.....		1870	Albert Ashenberger.....	7, 200
Modena, Utah.....	A.....		1901	Charles D. Asher.....	1, 850
Montgomery, Ala. (section center).....	A, B, C.....		1872	Patrick H. Smyth.....	8, 340
Mount Weather, Va.....			1904	James E. Fowler.....	2, 450
Nantucket, Mass.....	A.....		1896	George E. Grimes.....	2, 600
Narragansett Pier, R. I.....	A, E.....		1882	Margaret E. Conway.....	1, 500
Nashville, Tenn. (section center).....	A, B, C, D, I.....		1870	Roscoe Nunn.....	11, 950
New Haven, Conn.....	A, I.....	Yale University.....	1872	Leonard M. Tarr.....	7, 580
New Orleans, La. (district forecast and section center).....	A, B, C, D, I.....		1870	Isaac M. Cline, William B. Stockman.	28, 980
New York, N. Y.....	A.....		1870	James H. Scarr.....	31, 560
Norfolk, Va.....	A.....		1871	William G. Burns.....	10, 950
Northfield, Vt.....	A, I.....		1887	William A. Shaw.....	4, 160
North Head, Wash.....	A, E.....		1902	Walter F. Feldwisch.....	1, 570
North Platte, Nebr.....	A.....		1874	Alphonso W. Shilling.....	3, 270
Oklahoma, Okla. (section center).....	A, C, D, I.....		1890	J. P. Slaughter.....	11, 890
Omaha, Nebr.....	A, B, C.....		1870	Lucius A. Welsh.....	8, 990
Oswego, N. Y.....	A.....		1870	Julius G. Linsley.....	2, 000
Palestine, Tex.....	A.....		1881	Louis Dorman.....	2, 500
Parkersburg, W. Va. (section center).....	A, B, C.....		1881	Henry C. Howe.....	5, 450
Pensacola, Fla.....	A.....		1879	William F. Reed, jr.....	6, 020
Peoria, Ill.....	A, I.....		1905	Merton L. Fuller.....	6, 560
Philadelphia, Pa. (section center).....	A, B, C, D, I.....		1871	George S. Bliss.....	16, 500
Phoenix, Ariz. (section center).....	A, B, C, D, I.....	Forest Service.....	1895	Robert Q. Grant.....	7, 780
Pierre, S. Dak.....	A.....		1891	Dexter C. Grunow.....	1, 530
Pittsburgh, Pa.....	A, B.....		1870	Henry Pennywitt.....	16, 090
Pocatello, Idaho.....	A.....		1899	Arthur R. Teeple.....	1, 960
Port Angeles, Wash.....	A, E, F.....		1898	Leon G. Sutton.....	8, 920
Port Huron, Mich.....	A.....		1874	Abe Wiesner.....	2, 230
Portland, Me.....	A, B.....		1871	Edward P. Jones.....	6, 400
Portland, Oreg. (district forecast and section center).....	A, B, C, D, I.....	Forest Service.....	1871	Edward A. Beals.....	29, 480
Providence, R. I.....	A.....		1904	Charles S. Wood.....	7, 190
Pueblo, Colo.....	A.....		1888	Lawrence H. Daingerfield.	4, 090
Raleigh, N. C. (section center).....	A, B, C, D.....		1884	Lee A. Denson.....	12, 480
Rapid City, S. Dak.....	A.....		1888	Harley N. Johnson.....	2, 030
Reading, Pa.....	A.....		1912	Cornelius J. Doherty.....	4, 780
Red Bluff, Cal.....	A.....		1877	Noble M. Cunningham.....	2, 860
Reno, Nev. (section center).....	A, C.....	Forest Service.....	1905	Henry F. Alciatore.....	7, 160
Richmond, Va. (section center).....	A, B, C, D, I.....		1897	Edward A. Evans.....	8, 790
Rochester, N. Y.....	A.....		1870	Luther M. Dey.....	4, 680
Roseburg, Oreg.....	A.....		1877	William Bell.....	2, 880
Roswell, N. Mex.....	A.....		1904	Cleve Hallenbeck.....	1, 530
Sacramento, Cal.....	A, B.....		1877	Nathaniel R. Taylor.....	6, 790
Saginaw, Mich.....	A, B, I.....	Arthur Hill Trade School.	1912	Frank H. Coleman.....	4, 430

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DISTRIBUTION OF WORK BY STATIONS—Continued.

Location.	Character of work. ¹	Cooperation.	Date begun.	Assignment.	Proposed expenditures, 1916-17.
St. Joseph, Mo.....	A.....		1910	William S. Belden.....	\$5,380
St. Louis, Mo.....	A, B, C, D, I..	St. Louis University..	1870	Montrose W. Hayes....	23,100
St. Paul, Minn.....	A.....		1870	John N. Ryker.....	4,520
Salt Lake City, Utah (section center).	A, B, C, D, I..	Forest Service, Reclamation Service.	1874	Alfred H. Thiessen....	12,910
San Antonio, Tex.....	A.....		1885	Allen Buell.....	5,550
San Diego, Cal.....	A.....		1871	E. Herbert Nimmo....	4,840
Sandusky, Ohio.....	A.....		1877	Claude C. Cooper....	4,630
Sandy Hook, N. J.....	A.....		1914	Gustave S. Lindgren..	5,590
San Francisco, Cal. (district forecast and section center).	A, C, D, E, I..	Forest Service.....	1871	George A. Willson, Thomas R. Reed.....	35,490
San Jose, Cal.....	A.....		1905	Maurice Connell.....	1,640
San Juan, P. R., W. I. (section center).	A, C.....	Navy Department....	1898	F. Eugene Hartwell...	4,340
San Luis Obispo, Cal..	A.....		1894	John R. Williams.....	1,870
Santa Fe, N. Mex. (section center).	A, C, D, H, I..	Forest Service.....	1871	Charles E. Linney....	6,050
Sault Ste. Marie, Mich.	A.....		1877	Alexander G. Burns...	3,870
Savannah, Ga.....	A, C.....		1871	Charles M. Strong....	9,420
Scranton, Pa.....	A.....		1900	William M. Dudley....	4,690
Seattle, Wash. (section center).	A, C, D, I..	Forest Service.....	1893	George N. Salisbury...	14,940
Sheridan, Wyo.....	A.....		1907	Harry A. Frise.....	2,670
Shreveport, La.....	A, B.....		1871	James W. Cronk.....	4,880
Sioux City, Iowa.....	A, B.....		1889	Gilbert W. McDowall..	4,020
Spokane, Wash.....	A.....		1881	Charles Stewart.....	5,690
Springfield, Ill. (section center).	A, C, D, I..		1879	Clarence J. Root.....	8,610
Springfield, Mo.....	A, I.....		1887	Walter B. Hare.....	4,220
Syracuse, N. Y.....	A, I.....		1902	Morgan R. Sanford...	4,920
Tacoma, Wash.....	A.....		1897	Louis C. Cover.....	4,520
Tampa, Fla.....	A.....		1890	Walter J. Bennett....	4,850
Tatoosh Island, Wash.	A, E, F.....		1902	Ralph C. Mize.....	2,930
Taylor, Tex.....	A.....		1901	Herbert Tullsen.....	3,180
Terre Haute, Ind.....	A, B.....		1912	William R. Cade.....	6,890
Thomasville, Ga.....	A.....		1905	Olin M. Hadley.....	2,470
Toledo, Ohio.....	A.....		1870	William S. Currier....	5,680
Tonopah, Nev.....	A.....		1906	Hugo Legler.....	2,680
Topeka, Kans. (section center).	A, C, D, I..		1887	Thorp B. Jennings...	5,410
Trenton, N. J. (section center).	A, C, D, I..		1913	G. Harold Noyes.....	8,670
Valentine, Nebr.....	A.....		1885	Budd Evans.....	1,980
Vicksburg, Miss. (section center).	A, B, C, D, I..		1871	William H. Barron....	8,550
Wagon Wheel Gap, Colo.	A, C.....	Forest Service.....	1910	Alonzo A. Justice....	4,180
Walla Walla, Wash.....	A.....		1885	Charles C. Garrett....	3,680
Washington, D. C. (central office of the bureau, and district forecast center).	A, B, C, D, E, F, G, H, I, K.	Government of Canada, Smithsonian Institution, Alaska Agricultural Experiment Station.	1870	Charles F. Marvin, C. C. Clark, and others.	349,350
Wausau, Wis.....	A, B.....		1915	Ellwood E. Unger....	2,000
Wichita, Kans.....	A, B.....		1888	Samuel P. Peterson...	5,580
Williston, N. Dak.....	A.....		1893	John Craig.....	2,000
Wilmington, N. C.....	A, C.....		1871	George W. Felger....	4,100
Winnemucca, Nev.....	A.....		1884	Ray L. Fisher.....	1,810
Wytheville, Va.....	A.....		1902	James I. Widmeyer....	1,770
Yankton, S. Dak.....	A.....		1873	William H. Fallon....	1,680
Yellowstone Park, Wyo.	A.....		1903	Karl C. Rupert.....	2,580
Yuma, Ariz.....	A.....		1875	Sumner Hackett.....	1,540
Alaskan stations.....	A, C.....		1899	10 observers.....	12,500
West Indian and Caribbean Sea stations.	A, C.....		1898	12 observers.....	48,000
Cape Henry building..	Erection of building.				22,500
Total, Weather Bureau.....					1,747,260

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ALLOTMENT OF WEATHER BUREAU APPROPRIATIONS BY PROJECTS.

Projects.	Statutory salaries.	General expenses.				
		Central office expenses.	Printing office.	Station salaries.	Special observations and reports.	Telegraphing and telephoning.
Administration:						
General administration.....	\$43, 490	\$31, 590	-----	-----	-----	-----
Service:						
Forecasts and warnings.....	234, 450	31, 145	\$6, 245	\$291, 390	\$43, 340	\$255, 675
River and flood work.....	8, 000	6, 720	1, 515	59, 130	47, 500	18, 500
Climatological work.....	32, 800	13, 440	2, 950	236, 340	12, 000	500
Agricultural meteorology.....	2, 000	3, 360	1, 725	16, 390	26, 000	17, 475
Vessel reporting.....	2, 000	-----	-----	3, 450	-----	-----
Research:						
Improvement of instrumental equipment.....	2, 200	300	-----	-----	-----	-----
Investigations of the problems of forecasting.....	500	3, 750	-----	200	-----	-----
River and flood investigations.....	1, 000	1, 000	-----	1, 400	-----	-----
Investigations in climatology.....	1, 600	2, 000	40	2, 140	-----	-----
Aerological investigations.....	2, 640	4, 540	95	4, 100	1, 000	-----
Solar radiation investigations.....	1, 000	4, 445	65	2, 000	-----	-----
Evaporation investigations.....	680	200	45	4, 080	100	-----
Meteorological investigations.....	200	1, 585	15	-----	-----	-----
Seismological investigations.....	800	1, 665	20	495	-----	-----
Investigations in agricultural meteorology.....	2, 400	2, 810	85	5, 605	100	-----
Ice-storm and sleet investigations.....	300	700	-----	-----	-----	-----
Total.....	336, 060	109, 250	12, 800	626, 720	130, 040	292, 150

Projects.	General expenses.				Total.
	Miscellaneous station expenses.	Traveling expenses.	Buildings.	Total.	
Administration:					
General administration.....	-----	-----	-----	\$31, 590	\$75, 080
Service:					
Forecasts and warnings.....	\$104, 830	\$12, 925	-----	745, 550	980, 000
River and flood work.....	27, 285	2, 950	-----	163, 600	171, 600
Climatological work.....	46, 250	5, 800	-----	317, 280	350, 080
Agricultural meteorology.....	11, 625	1, 425	-----	78, 000	80, 000
Vessel reporting.....	2, 500	50	-----	6, 000	8, 000
Research:					
Improvement of instrumental equipment.....	-----	-----	-----	300	2, 500
Investigations of the problems of forecasting.....	-----	50	-----	4, 000	4, 500
River and flood investigations.....	50	100	-----	2, 550	3, 550
Investigations in climatology.....	50	-----	-----	4, 230	5, 830
Aerological investigations.....	525	100	-----	10, 360	13, 000
Solar radiation investigations.....	240	250	-----	7, 000	8, 000
Evaporation investigations.....	165	50	-----	4, 640	5, 320
Meteorological investigations.....	-----	-----	-----	1, 600	1, 800
Seismological investigations.....	20	-----	-----	2, 200	3, 000
Investigations in agricultural meteorology.....	200	300	-----	9, 100	11, 500
Ice-storm and sleet investigations.....	-----	-----	-----	700	1, 000
Building:					
Cape Henry building.....	-----	-----	\$22, 500	22, 500	22, 500
Total.....	193, 740	24, 000	22, 500	1, 411, 200	1, 747, 260

BUREAU OF ANIMAL INDUSTRY.

GENERAL ADMINISTRATION.

General Administration:

Object.—Supervision of the bureau activities and the performance of such duties as are common to the bureau as a whole, the cost of which can not be readily prorated against the various projects involved, such as accounting and editorial work, the distribution of supplies, and matters relating to the personnel.

Location.—Washington, D. C.

Date begun.—1884.

Assignment.—A. D. Melvin, J. R. Mohler, C. C. Carroll.

Proposed expenditures, 1916-17.—\$135,936, including \$105,750 statutory (regulation, \$120,000; research, \$10,750; extension, \$5,186).

ERADICATION AND CONTROL OF ANIMAL DISEASES.

Supervision:

Object.—To supervise all work connected with the eradication and control of animal diseases and prevent the interstate spread of the contagion of these diseases; to perform duties connected with the general work of eradication, including correspondence with the public and conferences with other branches of the Government service.

Location.—Washington, D. C.

Date begun.—1884.

Assignment.—M. Dorset, A. Eichhorn, R. W. Hickman, R. A. Ramsay.

Proposed expenditures, 1916-17.—\$8,980 (regulation).

[Regulation.]

Eradication of Scabies in Sheep:

Object.—To cooperate with States in which scabies in sheep exists by providing quarantine measures to prevent its spread and by demonstrating proper treatment, including the cleaning and disinfection of cars, pens, and other premises, thereby fostering the industry and encouraging greater production of mutton and wool.

Procedure.—Inspection of animals in the areas where scabies exists and dipping of diseased or exposed animals under State or Federal supervision.

Cooperation.—Live-stock sanitary organizations in Arizona, California, Tennessee, Nevada, New Mexico, Texas, Utah, Idaho, Kansas, Kentucky, Missouri, Oregon, and Washington.

Location.—States mentioned under "Cooperation."

Date begun.—1903.

Results.—Territory released from quarantine for scabies in sheep, 1,459,769 square miles, leaving 324,827 square miles still under Federal quarantine for this purpose. During the fiscal year 1915 there were 15,659,624 sheep inspected and 3,790,967 dipped for scabies. Sheep scabies now exists to a limited degree, and the complete elimination of the disease can only be accomplished by the closest possible cooperation between bureau employees inspecting sheep at market centers with those assigned to field duty and with live-stock sanitary officials in eradicating the disease from limited localities where it is found to exist.

Probable date of completion.—1918.

Assignment.—R. A. Ramsay, W. P. Ellenberger.

Proposed expenditures, 1916-17.—\$118,000.

Eradication of Mange (Scabies) in Cattle and Horses:

Object.—To eradicate scabies in cattle and horses by providing quarantine measures to prevent its spread and by demonstrating proper treatment, including the cleaning and disinfection of cars, pens, and other premises, thereby fostering the horse industry and increasing the production of beef and dairy products.

Procedure.—Inspection of animals in the areas where scabies exists and dipping diseased or exposed animals under State or Federal supervision.

Eradication of Mange (Scabies) in Cattle and Horses—Continued.

Cooperation.—Live-stock sanitary organizations in Idaho, Montana, Nebraska, Texas, Wyoming, New Mexico, Oklahoma, Kansas, Missouri, Oregon, and South Dakota.

Location.—States named under "Cooperation."

Date begun.—1905.

Results.—Territory released from quarantine for cattle scabies, 1,266,027 square miles, leaving 3,817 miles still under quarantine for this purpose. During the fiscal year 1915 there were 1,264,009 cattle inspected and 588,228 dipped. No territory has been quarantined specifically against scabies in horses, as the eradication of this disease has been conducted in conjunction with the eradication of cattle scabies. In order that scabies in cattle and horses may be completely eliminated from the country, it is of the utmost importance that the Federal Government continue to maintain at market centers very close inspection of all cattle and horses for scabies and report promptly to the department employees in the field and State live-stock sanitary officials any case of the disease found, to the end that local centers of infection may be promptly located and diseased animals properly treated under State or Federal supervision.

Assignment.—R. A. Ramsay, W. P. Ellenberger.

Proposed expenditures, 1916-17.—\$103,200.

Supervision of Interstate Transportation of Live Stock and Inspection of Southern Cattle outside the Quarantine Area:

Object.—To make a careful examination and inspection of all live stock unloaded at market centers and public stockyards where Federal inspection is maintained, to determine the presence in any of the animals of communicable diseases which might be transmitted to animals in other States; also to issue certificates covering interstate movement of animals free from disease or which have been treated under bureau supervision.

Cooperation.—Live-stock sanitary officials of the various States.

Location.—Sixty-four cities, more or less, at various points throughout the United States.

Date begun.—1884.

Results.—During the fiscal year 1915, 21,397,574 sheep were inspected and 748,849 dipped; 12,634,444 cattle were inspected and 18,332 dipped, in order that they might be continued in interstate transit.

During the same year there were cleaned and disinfected under bureau supervision 323,985 live-stock cars or cars which had contained live stock affected with or exposed to contagious diseases. This is a very great increase over previous years and includes cars requiring cleaning and disinfection under department regulations pertaining to the control and eradication of foot-and-mouth disease.

Assignment.—R. A. Ramsay, A. W. Miller.

Proposed expenditures, 1916-17.—\$100,000.

Enforcement of the 28-Hour Law:

Object.—To ascertain whether animals being shipped interstate have been unloaded for feeding, resting, and watering at such periods as are required by law; also to ascertain whether the animals have been handled in a humane manner at stockyards where such unloading is performed.

Procedure.—Bureau employees stationed at market or stockyard centers or feeding points en route are required to examine waybills issued by transportation companies for the purpose of ascertaining by notations made thereon when and at what points the animals were unloaded en route for the purpose of feed, rest, and water, and to report the facts to the bureau.

Cooperation.—Department of Justice, office of Solicitor of this department, and various transportation companies and shippers of live stock.

Location.—United States.

Date begun.—1906.

Results.—During the fiscal year 1915 there were submitted to the Department of Justice 582 cases of alleged violation of the 28-hour law. The penalties imposed in the cases decided in favor of the Government amounted to \$80,300. The enforcement of this law has resulted in securing better facilities for the feeding, watering, and handling of live stock in transit.

Assignment.—R. A. Ramsay, W. P. Ellenberger.

Proposed expenditures, 1916-17.—\$20,000.

- (**Inspection and Tuberculin Testing of Cattle and Mallein Testing of Horses for Interstate Movement:** Discontinued as a separate project; included under "Inspection and Tuberculin Testing of Cattle and Mallein Testing of Horses.")
- (**Investigating Alleged Violations of Live-Stock Quarantine Regulations:** Discontinued as a separate project; included under "Inspection Relative to Existence of Contagious Diseases.")
- (**Supervision of the Inoculation of Swine against Hog Cholera for Interstate Movement from Public Stockyards:** Discontinued as a separate project; included under "Inspection Relative to Existence of Contagious Diseases.")
- (**Eradication of Tuberculosis among Dairy Herds:** Discontinued as a separate project; included under "Inspection and Tuberculin Testing of Cattle and Mallein Testing of Horses.")
- (**Tuberculin Testing of Pure-Bred Breeding Cattle:** Discontinued as a separate project; included under "Inspection and Tuberculin Testing of Cattle and Mallein Testing of Horses.")
- (**Manufacture and Distribution of Tuberculin:** Discontinued as a separate project; included under "Preparation and Distribution of Tuberculin, Mallein, and Blackleg Vaccine.")
- (**Manufacture and Distribution of Mallein:** Discontinued as a separate project; included under "Preparation and Distribution of Tuberculin, Mallein, and Blackleg Vaccine.")
- (**Control of Glanders and Scabies in Horse Stock in the District of Columbia:** Discontinued as a separate project; included under "Inspection Relative to Existence of Contagious Diseases.")
- (**Control of Animal Diseases in Porto Rico and Hawaii:** Discontinued as a separate project; included under "Inspection Relative to Existence of Contagious Diseases.")
- (**Manufacture and Distribution of Blackleg Vaccine:** Discontinued as a separate project; included under "Preparation and Distribution of Tuberculin, Mallein, and Blackleg Vaccine.")

Inspection Relative to Existence of Contagious Diseases:

Object.—To investigate alleged violations of the live-stock quarantine regulations; supervise the inoculation of swine against hog cholera for interstate movement from public stockyards; control animal diseases in Porto Rico; and control glanders and scabies in horse stock in the District of Columbia.

Procedure.—Bureau employees stationed at market or stockyard centers or feeding points en route are required to examine waybills issued by transportation companies for the purpose of ascertaining whether the shipment of live stock covered thereby is from an area under Federal quarantine for contagious diseases or whether it is accompanied by a certificate of inspection or treatment issued by an inspector of this bureau permitting such interstate movement from the area under quarantine. Bureau veterinarians are detailed to public stockyards to make a careful inspection of swine, and, if found free from symptoms of cholera or other contagious or communicable diseases, to supervise their immunization against cholera at the expense and risk of the owner by either the "serum alone" method or the "simultaneous inoculation" method, as may be decided upon by the owner; to supervise the disinfection after either treatment above mentioned and to see that the animals are loaded into properly cleaned and disinfected cars for interstate movement. Import animals are inspected and quarantined as required, possible outbreaks of disease are investigated, and measures are taken to prevent the spread of diseases and to eradicate them in Porto Rico. Animals in the District of Columbia which have been exposed to or are suspected of being affected with glanders or scabies are inspected and tested, and, when necessary, the animals are slaughtered or quarantined and the premises quarantined and disinfected.

Cooperation.—Supervision of the inoculation of swine is conducted in accordance with the laws and regulations of the States to which interstate shipments of swine are destined. The local authorities in Porto Rico and the District Commissioners in Washington, D. C., cooperate with the bureau.

Inspection Relative to Existence of Contagious Diseases—Continued.

Location.—Washington, D. C., and 64 bureau stations, more or less, in various sections of the United States; also San Juan, P. R.

Date begun.—1884.

Results.—During the fiscal year 1915 there were submitted to the Department of Justice 189 cases of alleged violations of the quarantine laws and regulations. The fines imposed in the cases decided in favor of the Government amounted to \$17,080. During the fiscal year 1915 there were 20,759 swine immunized against cholera for interstate movement from public stockyards for purposes other than immediate slaughter. Importation of diseased animals and serious outbreaks of disease in Porto Rico have been prevented. No outbreak of glanders occurred in the District of Columbia during the past year, but several horses badly affected with scabies were destroyed and stables and utensils disinfected.

Assignment.—R. W. Hickman, R. A. Ramsay.

Proposed expenditures, 1916-17.—\$9,400.

Inspection and Tuberculin Testing of Cattle and Mallein Testing of Horses:

Object.—To prevent the spread of tuberculosis of cattle and of glanders in horses and mules through interstate movement; to prevent the spread of tuberculosis in dairy herds of cattle, and to provide milk supplies from cattle free from tuberculosis; to prevent the spread of tuberculosis among pure-bred breeding cattle, and to establish a public registry of pure-bred herds which have been shown to be free from tuberculosis, in order that breeders throughout the country may have assurances of the healthfulness of pure-bred cattle which they are purchasing for the improvement of their herds.

Procedure.—On request of transportation company or shipper at the stockyards of a station where bureau inspection is maintained in other classes of work, veterinarians are detailed to inspect and test cattle with tuberculin, and horses, mules, and asses with mallein, and, if found free from disease, to issue interstate certificates therefor in compliance with the laws of the State to which destined. Animals found to be diseased with tuberculosis or glanders are required to be disposed of in accordance with the laws of the State in which the diseases are discovered. Dairy herds and pure-bred cattle are tested upon the voluntary request of their owners. The presence of tuberculosis is determined by the application of the subcutaneous tuberculin test assisted by a physical examination of the animals and a careful investigation into the health history of the herds in which tuberculosis eradication is undertaken.

Cooperation.—Work is conducted in accordance with the laws and regulations of the State to which interstate shipments of animals are destined; owners of dairy herds and pure-bred breeding cattle, live-stock sanitary authorities, municipal health departments, breed record associations, and the Office of Indian Affairs, Department of the Interior, cooperate.

Location.—For interstate movement, at 47 cities, more or less, throughout the United States at which veterinary inspectors are stationed; dairy herds, District of Columbia, Virginia, Maryland, and the various Indian reservations; pure-bred breeding cattle, at various points throughout the United States wherever such herds are located.

Date begun.—1907.

Results.—For interstate movement, during the fiscal year 1915 there were 53,293 cattle inspected, of which 14,618 were tested with tuberculin; 25,392 horses and mules inspected, of which 7,425 were tested with mallein. Among dairy herds and pure-bred breeding cattle, approximately 75,000 cattle have been tested upon 2,500 farms, in 350 towns, showing approximately 15 per cent of tuberculous cattle in these herds.

Assignment.—R. W. Hickman, R. A. Ramsay.

Proposed expenditures, 1916-17.—\$75,000.

Preparation and Distribution of Tuberculin, Mallein, and Blackleg Vaccine:

Object.—To furnish supplies of tuberculin and mallein for the testing of animals, and of blackleg vaccine, with a view to prevent blackleg in cattle.

Procedure.—Tuberculin, mallein, and blackleg vaccines are manufactured in the laboratories at Washington and are furnished free of cost to Federal, State, county, and municipal officials; in addition, blackleg vaccine is distributed free to owners of cattle upon request. In distributing these preparations it is understood that the tuberculin is to be used only in making official tests and that reports of the results obtained through the use of the tuberculin and mallein are to be made to the bureau.

Preparation and Distribution of Tuberculin, Mallein, and Blackleg Vaccine—Continued.

Location.—Washington, D. C.

Date begun.—1892.

Results.—During the fiscal year 1915, 455,702 doses of tuberculin, 368,530 doses of mallein, and 3,454,628 doses of blackleg vaccine were prepared and distributed.

Assignment.—M. Dorset, A. Eichhorn, R. W. Hickman.

Proposed expenditures, 1916-17.—\$18,300.

[Research.]

Investigation and Chemical Testing of Dips and Disinfectants:

Object.—To insure the employment of properly compounded preparations in official dipping and disinfecting operations.

Procedure.—Chemical investigations are made of dips and disinfectants, of methods of compounding them, and of methods of chemical analysis appropriate for (1) accurate laboratory investigations and (2) field tests.

Location.—Washington, D. C., although samples are collected from various points in the field as particular investigations require.

Date begun.—1907.

Results.—Dips and disinfectants have been standardized, new formulas developed, new methods for laboratory analysis and field test devised, and a number of papers published on the subjects under investigation.

Assignment.—R. M. Chapin.

Proposed expenditures, 1916-17.—\$5,000.

Total, Eradication and Control of Animal Diseases, \$457,880, including \$17,100 statutory (regulation, \$452,880; research, \$5,000).

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS, AND EXPORT LIVE-STOCK INSPECTION.

Supervision:

Object.—Supervision of the work of inspection and quarantine of imported animals and of export live-stock inspection and the performance of duties common to the whole work.

Cooperation.—Treasury Department and the Department of State.

Location.—Washington, D. C.

Date begun.—1884.

Assignment.—R. W. Hickman.

Proposed expenditures, 1916-17.—\$5,600 (regulation).

[Regulation.]

Inspection of Animals for Importation:

Object.—To prohibit the importation of diseased animals through inspection at ports of entry and the establishment of quarantines when necessary.

Procedure.—When presented for entry at Canadian or Mexican border ports animals are inspected by bureau inspectors and rejected, quarantined, or passed, according to circumstances. Animals permitted importation from countries other than those of North America are inspected on the vessel before landing, and those requiring quarantine under the regulations are transferred to quarantine stations for observation. Upon request of prospective importers, bureau inspectors in Great Britain apply tuberculin tests to cattle intended for shipment to the United States.

Cooperation.—Collectors of customs at ports of entry and American consuls in foreign countries.

Location.—Ports of entry for import animals along the Mexican border in Arizona, California, and Texas; the Canadian border in Maine, Vermont, New York, Michigan, North Dakota, Montana, and Washington; and for animals from other than North American countries, ports of entry in the States of Massachusetts, New York, Maryland, California, and Washington. Upon application of importers, cattle in Great Britain are tuberculin tested before shipment to this country by an inspector stationed in England.

Date begun.—1884.

Results.—During the fiscal year 1915 there were 955,893 import animals inspected, of which 4,622 were quarantined. The tuberculin test was applied to 660 cattle in Great Britain for importation into the United States.

Assignment.—R. W. Hickman.

Proposed expenditures, 1916-17.—\$67,000.

(**Inspection of Animals for Importation from Mexico:** Discontinued as a separate project; included under "Inspection of Animals for Importation.")

(**Inspection of Animals for Importation from Canada:** Discontinued as a separate project; included under "Inspection of Animals for Importation.")

(**Inspection of Animals for Importation from Other than North American Countries:** Discontinued as a separate project; included under "Inspection of Animals for Importation.")

(**Inspection and Testing of Animals in Great Britain Intended for Export to the United States:** Discontinued as a separate project; included under "Inspection of Animals for Importation.")

Quarantine of Animals at Ports of Entry:

Object.—To prohibit the importation of diseased animals.

Procedure.—Animal quarantine stations are provided by the department and equipped with buildings and facilities for detention and isolation of live stock. Ruminants and swine and collie and shepherd dogs are held under supervision, as provided by regulations, and during the period of quarantine are carefully observed and subjected to blood or other tests as deemed necessary.

Location.—Turner (Baltimore), Md.; Athenia (New York), N. J.; and Littleton (Boston), Mass.

Date begun.—1884.

Results.—During the fiscal year 1916, owing to the occurrence of outbreaks of foot-and-mouth disease in England, the department discontinued the issuance of permits for the importation of ruminants and swine from that country during the period October 15, 1915, to April 30, 1916. From July 1, 1915, to October 15, 1915, there were quarantined 458 cattle, 199 sheep, and 10 swine. Four sheep, for which a permit was issued before the outbreak of foot-and-mouth disease in Great Britain in October, arrived at the port of Boston in November, and were quarantined. During May, 1916, 307 cattle, 5 sheep, and 1 swine were quarantined, and permits were outstanding for the importation during the month of June of 401 cattle, 110 sheep, and 10 swine; also for 2 wild boars, 4 deer, and 1 goat. In addition to the above, there were quarantined from July, 1915, to May, 1916, inclusive, 56 dogs, 11 camels, 4 antelopes, 7 deer, and 1 peccary. During the same period, 156 sheep from New Zealand were quarantined at San Francisco and permits were outstanding for the entry and quarantine of 895 sheep at that port.

Assignment.—R. W. Hickman.

Proposed expenditures, 1916-17.—\$18,000.

Supervision over Importations of Hay, Forage, Hides, Hair, Wool, and Other Animal By-Products, etc.:

Object.—To prevent the introduction of animal diseases.

Procedure.—Inspectors at ports of entry, in cooperation with customs officials, prevent the landing of prohibited feedstuffs, animal by-products, etc., and supervise disinfection as required. Certain forms of certificates are required to accompany hides, hair, and wool from various countries, and in some instances such materials when not duly certified are after whitewashing in bales permitted shipment to a factory or tannery having proper facilities and there disinfected under bureau supervision.

Cooperation.—In this work there is more or less cooperation with collectors of customs at ports of entry and American consuls in foreign countries; also with proprietors or officials of various tanneries at which hides are disinfected or factories and mills where hair and wool are treated.

Location.—Various ports of entry where bureau inspection is maintained.

Date begun.—1890.

Results.—There have been no instances of the introduction of infection through such products over which the bureau has maintained supervision.

Assignment.—R. W. Hickman.

Proposed expenditures, 1916-17.—\$500.

Inspection and Testing of Animals for Export to Foreign Countries:

Object.—To insure freedom of export animals from disease.

Procedure.—Animals are inspected and tested as required by countries to which exported and reinspected at ports of export and certificates issued.

Cooperation.—Canadian Government.

Location.—Various bureau stations and other places as may be required.

Date begun.—1890.

Inspection and Testing of Animals for Export to Foreign Countries—Cont'd.

Results.—During the fiscal year 1915 there were 7,644 animals inspected prior to shipment.

Assignment.—R. W. Hickman.

Proposed expenditures, 1916-17.—\$2,500.

Inspection of Vessels Carrying Export Animals:

Object.—To provide for the safe transportation and humane treatment of export live stock.

Procedure.—Vessels are surveyed and construction of fittings supervised to conform to department regulations; loading is supervised.

Cooperation.—Collectors of customs at ports of shipment.

Location.—Vessels are inspected at ports of export in the States of Maine, Massachusetts, New York, Pennsylvania, Maryland, Virginia, South Carolina, Louisiana, Texas, California, and Washington.

Date begun.—1891.

Results.—There were 157 inspections of vessels carrying live stock during the fiscal year 1915.

Assignment.—R. W. Hickman.

Proposed expenditures, 1916-17.—\$2,000.

[Research.]

Investigation of Methods of Disinfecting Hides:

Object.—To determine the best methods for the disinfection of hides, in order to prevent the introduction of infectious material.

Procedure.—Bacteriological studies are made of the effect of disinfectants on various disease-producing microorganisms, particularly anthrax; the effect of disinfectants on such organisms when placed on hides is also studied.

Location.—Washington, D. C.

Date begun.—1912.

Results.—Effectiveness of Seymour-Jones and Schattenfroh methods determined and results published in the Journal of Agricultural Research, April 15, 1915.

Assignment.—F. W. Tilley.

Proposed expenditures, 1916-17.—\$1,000.

Total, Inspection and Quarantine of Imported Animals, and Export Live-Stock Inspection, \$96,600, including \$4,600 statutory (regulation, \$95,600; research, \$1,000).

[Regulation.]

ERADICATION OF CATTLE TICKS.**Eradication of Cattle Ticks:**

Object.—The extermination of the ticks which spread the infection of splenic fever of cattle.

Procedure.—Educational and demonstration work followed by the systematic dipping of cattle in arsenical solution to prevent the propagation of ticks, or by the total removal of cattle from pastures for a time, to the end that ticks may not find a host on which to develop.

Cooperation.—The State live-stock sanitary organizations in Alabama, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

Location.—States mentioned under "Cooperation."

Date begun.—1906.

Results.—Since this work was begun ticks have been exterminated from approximately 284,521 square miles of territory and the area released from Federal quarantine. During the year ending December 31, 1915, there were released as free from ticks 49,629 square miles. As an indication of the work required to accomplish these results, it may be stated that during the past calendar year 11,268,668 inspections of cattle were made for ticks and there were in operation 6,678 dipping vats where all animals found to be infested with or exposed to ticks were dipped under Federal or State supervision.

Probable date of completion.—1924.

Assignment.—R. A. Ramsay, W. P. Ellenberger, J. A. Kiernan.

Proposed expenditures, 1916-17.—\$593,160, including \$10,760 statutory.

[Extension.]

LIVE-STOCK DEMONSTRATION WORK IN AREAS FREED FROM CATTLE TICKS.**Live-Stock Demonstration Work in Tick-Freed Areas:**

Object.—To demonstrate to farmers the best means within their reach to improve and develop better live-stock industry and dairying in the areas freed from cattle ticks in the Southern States.

Procedure.—Reorganization of tick-eradication associations and county live-stock associations into organizations for the purpose of devising ways and means of introducing better live stock into the community and to develop better pastures and forage crops in order that live stock may be properly cared for. For this purpose there are assigned to each State one or more employees experienced in animal husbandry and the dairy industry, whose duty it is to cooperate with agents in the employ of the States Relations Service and with State employees doing the same class of work. Bureau veterinarians engaged in tick eradication are instructed to cooperate with these different forces in the inspection and tuberculin testing of live stock for disease, to the end that disease may not be introduced by live stock brought into tick-freed areas.

Cooperation.—States Relations Service and extension divisions of agricultural colleges in the States mentioned under "Location."

Location.—Various localities which have been freed from ticks in Louisiana, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Arkansas, Oklahoma, and Texas.

Date begun.—1914.

Results.—During the past year over 25 new county live-stock associations were formed, with a membership of more than 725 stockmen. Over 350 head of pure-bred cattle were purchased as a direct result of the work of the live-stock specialists. The majority of these animals were bulls. About 400 addresses were made to audiences comprised of approximately 25,000 people. Three thousand five hundred cattle were used in conducting feeding demonstrations on 100 different farms, and the results were used for public lectures and articles for local papers. Seventy-five pasture demonstrations (1,000 acres) were made in various localities showing the value of improved pastures. In addition, dehorning, vaccinating, and castrating demonstrations were given in every State. Considerable help has been given farmers desiring to build silos, barns, corrals, and paddocks. In South Carolina several hundred head of cattle were fed by small farmers and later gathered at concentration pens where they were sold at public sale to buyers from packing-house and live-stock markets. The feeding and selling was done under the supervision of the live-stock specialists. Plans have been made to enlarge the work during the coming year and to construct special pens, with scales, etc., to facilitate the handling of the cattle.

Nine dairy specialists are at work in tick-freed areas. Demonstrations in butter making to improve the quality of country butter has been an important line of work. In one section 10 public demonstrations, supplemented by 75 home demonstrations, resulted in the purchase of 9 barrel churns, 53 square butter molds, 47 thermometers, and a cream separator. One woman sold her butter at an increase of 10 cents a pound. In one State 10 cream routes were organized, 47 cream separators purchased, 31 milk houses built, and 7 remodeled. Two bull associations have been formed, several carloads of feed bought co-operatively, and many pure-bred sires introduced. Demonstrations (separating, butter making, and milk testing) have been conducted at rural schools. Assistance has been given in the keeping of herd records and in the building of silos, dairy barns, and milk houses. In one section where there was no dairying a cream route has in 11 months resulted in 40 patrons, who sold approximately \$3,000 worth of cream.

Assignment.—R. A. Ramsay, B. H. Rawl, G. M. Rommel, of this bureau; Bradford Knapp and employees of the States Relations Service in charge of field forces in the Southern States.

Proposed expenditures, 1916-17.—\$50,000.

DAIRY INVESTIGATIONS.

ADMINISTRATION.

Administration:

Object.—General supervision of the Dairy Division work, including branch library, files, requisitions and accounts, dairy engineering, compilation and indexing, editorial and stenographic work, and stores.

Location.—Washington, D. C.

Date begun.—1895.

Assignment.—B. H. Rawl.

Proposed expenditures, 1916-17.—\$29,315, including \$9,920 statutory (research, \$14,695; extension, \$12,620; regulation, \$2,000).

DAIRY FARMING.

Supervision:

Object.—General supervision and office correspondence and record work; compilation of material for use in field work and preparation of manuscripts.

Location.—Washington, D. C.

Date begun.—1906.

Assignment.—Helmer Rabild.

Proposed expenditures, 1916-17.—\$14,380 (extension, \$9,000; research, \$5,380).

[Extension.]

Southern Dairying:

Object.—To encourage the development of the dairy business by instruction and demonstration.

Procedure.—Farmers are instructed in the feeding of dairy cows, the raising of calves, and the construction of silos and dairy buildings. Herd records are introduced and advice given in the selection of pure-bred bulls. An endeavor will be made to improve the quality of dairy products. Work will be taken up with rural schools and creamery extension work done in cooperation with the dairy manufacturing section.

Cooperation.—Extension departments of the colleges of agriculture in the States named under "Location."

Location.—North Carolina, South Carolina, Georgia, Alabama, Tennessee, Mississippi, Louisiana, Arkansas, Oklahoma, and Texas.

Date begun.—1905.

Results.—During the past year there were established two cooperative cheese factories, and one private factory was established in North Carolina; a creamery in North Carolina, producing 20,000 pounds of butter per month; and creameries at the agricultural colleges of North Carolina, South Carolina, Alabama, Tennessee, and Louisiana. Forty cream routes were organized, 27 of which brought the product of 1,105 cows from new territory to available markets; 257 cream separators purchased; farm butter work conducted in 5 counties in Georgia resulted in the purchase of 47 thermometers, 53 square butter molds, 9 barrel churns, and a cream separator; reduction of the cost of butter fat of 326 cows in a cow-testing association from 39 cents to 32.6 cents per pound, a total saving of \$5,200; 40 dairy houses built on 10 cream routes; work in one rural school resulted in the sale of 9-cream separators and the shipment of 1,000 pounds butter fat per month in a community where there had previously been absolutely no dairying.

Assignment.—J. H. McClain.

Proposed expenditures, 1916-17.—\$17,740.

Dairy Demonstration Farm:

Object.—To demonstrate the practicability of reclaiming a worn-out cotton farm by dairying.

Procedure.—A pure-bred bull will be used in the dairy herd, records kept of the production of each cow, and heifer calves from only the best cows retained in the herd. Home-grown roughage will be used so far as possible, crop rotations established, suitable buildings erected, and permanent pastures established.

Cooperation.—Denison Board of Trade.

Location.—Denison, Tex.

Date begun.—1907.

Dairy Demonstration Farm—Continued.

Results.—A demonstration herd was started with scrub cows and a pure-bred bull. The milking herd now numbers 20 mature cows and 40 heifers and is of a uniform type. The butter production has been increased from 139 pounds to 241 pounds. The average production of heifers with three lactation periods is 5,208 pounds of milk and 252 pounds of butter fat, while their dams averaged 4,315 pounds of milk and 197.8 pounds of butter fat. The fertility of the farm has been greatly increased by the addition of the manure from the dairy herd and 1,000 loads of manure hauled from Denison. Excessive erosion of the soil has been practically stopped. Various forage crops have been tried out. Corn has not proved satisfactory. Milo maize and kafir corn have been used successfully for silage. Thus far, cowpeas and alfalfa have not been grown with favorable results. The dairy building has been equipped with steam and other appliances. The farm has been fenced and freed from Texas cattle ticks, and the herd is free from tuberculosis.

Probable date of completion.—1917.

Assignment.—S. B. Durham.

Proposed expenditures, 1916-17.—\$1,620.

Cow-Testing Associations and Cooperation with County Agents in Dairy Work:

Object.—To increase economically the average milk and butter production of the dairy cows in the United States, and to assist county agents with general dairy work, such as silo and dairy building construction, feeding, care, and management of dairy cattle, special assistance at fairs, etc.

Procedure.—A campaign will be conducted to investigate the general profitability of dairy herds, to eliminate the unprofitable cows, and build up the herds by the use of pure-bred bulls and by the selection of females. Cooperative cow-testing associations will be organized and advice and assistance given in their supervision. Where the State can be interested in this work, the supervision of the associations will be under the extension department of the State agricultural college. Upon request, advice and assistance will be given county agents along different lines of dairy work. A dairy specialist will join the county agent for a week or two to help start special lines of dairy work. The county agent is usually not trained in dairying, but with a little assistance occasionally from one so trained the work may be conducted on broad constructive lines. The specialist will assist him in the construction of silos, dairy barns, dairy houses, in the organization of cow-testing and other dairy associations, and dairy campaigns of all kinds.

Cooperation.—States Relations Service and State agricultural colleges; project agreements are entered into with the extension departments of the agricultural colleges of the States in which the work is done.

Location.—Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, Pennsylvania, Delaware, Maryland, West Virginia, Ohio, Indiana, Michigan, Wisconsin, Iowa, Minnesota, and Nebraska.

Date begun.—Cow-testing association work was begun in 1908, and county agent cooperation in 1914.

Results.—350 cow-testing associations have been organized and records kept of 150,000 cows. In some associations the profits have doubled in four years, and the records indicate that an increased profit of \$10 a cow over the previous year is not exceptional. Feeds have been selected adapted to the needs of the cows without increasing the cost of the ration. This work introduces business systems of record keeping on the dairy farm and fosters cooperation. B. A. I. Circular 179, "Cow-Testing Associations," and publications from a number of States cooperating have been issued.

Assignment.—Helmer Rabild.

Proposed expenditures, 1916-17.—\$25,720.

[Research.]

Community Development in Dairying:

Object.—To determine the practicability of the small community raising its economic status through the employment of a field instructor skilled in dairying.

Procedure.—One man will work among the patrons of the creamery making a survey of the status of the dairy operations of the farms, the number of cows kept, the feeding, care, average production, net returns, etc. With these data as a basis, he will endeavor to introduce constructive methods of improving the economic status of dairy farming in that community, through the disposal

Community Development in Dairying—Continued.

of unprofitable cows and breeding the best animals to pure-bred dairy bulls, and instruction in proper crop rotations, the feeding of the herd, etc. He will assist in the construction of silos and other dairy buildings and give lectures at farmers' institutes. If possible, cow-testing associations, bull associations, and junior cow-testing clubs will be organized. Advice and instruction will be given concerning the care of milk and cream on the farm and its delivery to the creamery in the best possible condition. The purpose of this work is to ascertain the practicability of such a project for a community.

Cooperation.—Grove City Creamery Co., Grove City, Pa.

Location.—Grove City, Pa.

Date begun.—1910.

Results.—This work was started at Algona, Iowa, in 1910. Forty-six dairy houses, 21 new dairy barns, and a number of silos have been built. Thirty-one patrons now wash and scald their separators twice a day. Ten patrons have milk coolers. Dairy farmers' picnics, in the nature of special dairy meetings, have been instituted during the summer season; a boys' encampment established; a cow-testing association formed; and cream grading established at the creamery, which resulted in better cream and a better price for butter fat. The net returns as a result of the higher price for butter fat amounted to \$3,000 annually. The average production of the cows was greatly increased, and with the same number of cows the increase in income has been approximately \$7,000 annually. One hundred pure-bred dairy cows and 30 pure-bred bulls have been purchased.

Assignment.—R. R. Welch.

Proposed expenditures, 1916-17.—\$2,040.

Investigations in Cow-Testing Associations:

Object.—To determine the best form of cooperation for the development and increase in production of the dairy herds of the United States.

Procedure.—A study is made of the best methods in vogue in the most successful cow-testing associations and an adaptation of this work applied to the various sections of the United States. Summaries of the production and other records of cow-testing associations are compiled and studied with a view to bring out any features which can be put into successful operation. An educational course for cow testers has been worked out, uniform blanks prepared, and their adoption by the various State authorities secured. An endeavor will also be made to evolve a simple cost-accounting system for the dairy farm to be administered through cooperation with dairy-testing associations.

Location.—Throughout the United States.

Date begun.—1908.

Results.—Compilations have been made of the records of a large number of cow-testing associations, and these results have been arranged in chart form to be used in extension work along this line.

Assignment.—Helmer Rabild.

Proposed expenditures, 1916-17.—\$2,700.

Investigations in Bull Associations:

Object.—To determine the best form of cooperation and organization for the development of bull associations.

Procedure.—Studies will be made of the active and defunct bull associations to ascertain the causes of failures and to determine the best form of cooperation and organization. An effort will be made to organize a small number of associations in different but representative sections of the country for the purpose of studying the adaptation of this work to different localities. Records of the animals will be kept to determine the relative merits of various bulls and strains of cattle in the improvement of the production of herds.

Location.—Throughout the United States.

Date begun.—1914.

Results.—A partial survey has been made of active and defunct associations. Faulty organization and lack of assistance and supervision have been the cause of most of the failures. A tentative plan of organization has been formulated. Eight associations, owning 37 bulls, have been organized in territory where scrub bulls were formerly used, in Minnesota, Iowa, Wisconsin, Maryland, Oklahoma, Connecticut, and South Carolina.

Assignment.—J. G. Winkjer.

Proposed expenditures, 1916-17.—\$3,300.

Holstein Cattle Breeding:

Object.—To breed Holstein cattle suitable for conditions in the semiarid portions of the West.

Procedure.—The organization of a cattle-breeding circuit similar to a combined cow-testing association and bull association. An agent employed jointly by the U. S. Department of Agriculture and the North Dakota Agricultural College will keep records of the breeding operations, feed consumed, and the milk and butter-fat production of the cows. An executive council will make regulations for the care of all animals and the sale of surplus stock. Experts will decide on the sale prices of animals sold.

Cooperation.—North Dakota Agricultural College.

Location.—New Salem, N. Dak.

Date begun.—1908.

Results.—An association has been organized which has 10 members with 236 cows and 10 pure-bred service bulls. Twenty cows have been placed in advanced registry, and 60 per cent of the pure-bred cows made over 300 pounds of butter fat last year. A number of pure-bred bulls and grade heifers and cows have been sold to other sections of the State, the demand far exceeding the supply. Last year 31 pure-bred bulls were sold from the association. The 10 members now grow alfalfa and buy concentrated feed in carload lots. Details are given in "Report of Four Years' Work of the North Dakota Holstein Cattle Breeding Circuit," Bulletin 109 of the North Dakota Agricultural Experiment Station.

Probable date of completion.—1917.

Assignment.—U. J. Downey.

Proposed expenditures, 1916-17.—\$1,000.

Total, Dairy Farming, \$68,500, including \$3,900 statutory extension, \$54,040; research, \$14,460).

DAIRY MANUFACTURING.**Supervision:**

Object.—General supervision of all work in dairy manufacturing, including extension work done with creameries by correspondence; compilation of information collected.

Location.—Washington, D. C.

Date begun.—1906.

Assignment.—S. C. Thompson, William White.

Proposed expenditures, 1916-17.—\$9,495 (extension, \$4,995; research, \$3,600; regulation, \$900).

[Extension.]

Creamery Extension:

Object.—To improve the quality of milk and cream delivered to creameries, the quality of the product, and the general efficiency of creameries.

Procedure.—Through personal visits, correspondence, circular letters, and a system of creamery reports, advice is given in regard to establishing, building, equipping, operating, and managing creameries; to creamery patrons advice concerning the production and handling of milk and cream, the breeding, feeding, and managing of dairy cattle, the erection of silos and dairy buildings, and the keeping of herd records.

Cooperation.—Extension departments of the Vermont, Texas, South Dakota, North Dakota, Wisconsin, Minnesota, and Iowa agricultural colleges.

Location.—United States.

Date begun.—1908.

Results.—Many new creameries have been located and built in accordance with advice and plans from this division. Efficiency in creamery operation has been improved, as indicated by a material increase in the over-run obtained. Accounting systems have been improved. At certain creameries the quality of cream received has been greatly improved by the employment of a cream-grading system. This increased the financial returns to the creamery and to the patrons. The expense of operation has been decreased in several creameries by installing exhaust-steam water heaters and by improvement in the operation of the boilers and engines. Silos, dairy buildings, and ice houses have been erected under the supervision of field men, herds improved through purchase and breeding, herd records kept, production increased through better herd management, and the dairy industry in general benefited in those localities to which special attention has been given.

Assignment.—Wm. White, C. W. Fryhofer, F. L. Odell, J. L. Thomas, O. A. Storvick, T. A. Meehan.

Proposed expenditures, 1916-17.—\$15,200.

Cheese Factory Extension:

Object.—To encourage the building of cheese factories in localities where the industry will prove successful; to improve the quality of milk delivered to cheese factories; to improve the methods of making and hence the quality of cheese; and to increase the general efficiency of cheese factories and their management.

Procedure.—Cheese factories will be asked to report monthly and annually to this division. Circular letters and correspondence will be sent to cheese factories relative to cheese-making problems. Representatives will visit factories to give instruction and will attend meetings of cheese-factory patrons.

Cooperation.—Extension divisions of the agricultural colleges named under "Location."

Location.—North Carolina, Tennessee, and Idaho; to be extended to other States.

Date begun.—1914.

Results.—Five cheese factories have been organized in the mountainous section of North Carolina and are being successfully operated. Several cheese factories in Idaho were given assistance in improving the quality of their product and preparatory work was done in Montana, Tennessee, and West Virginia.

Assignment.—C. F. Doane, L. A. Perce.

Proposed expenditures, 1916-17.—\$7,630.

Farm Butter Making:

Object.—To improve the quality of the dairy butter produced in Tennessee, Alabama, North Carolina, South Carolina, and Georgia; and to promote dairy development in that territory.

Procedure.—A dairy manufacturing specialist calls on dairy farmers in the territory involved and gives them instructions in the art of butter making; he also acts as general adviser in dairy matters and attends meetings of farmers and dairymen.

Cooperation.—Extension departments of agricultural colleges in the States named under "Object."

Location.—Tennessee, Alabama, North Carolina, South Carolina, and Georgia.

Date begun.—1913.

Results.—A general survey of dairy conditions in the territory mentioned was made in order to learn what methods could best be used in the development of the dairy industry. It was found that the region is well adapted to dairying, but that there were not cows enough in the various communities to justify the establishment of creameries. It is therefore necessary to develop farm butter making. Many farmers have become interested in this work. Data on this work are published in Farmers' Bulletin 541, "Farm Butter Making."

Assignment.—G. A. Gilbert.

Proposed expenditures, 1916-17.—\$2,800.

[Research.]

Creamery Management Investigations:

Object.—To study methods for improving the quality of the milk and cream delivered to creameries and the quality of creamery butter, and to increase the general efficiency of creameries.

Procedure.—Through personal visits, correspondence, and personal supervision of certain creameries, data are gathered showing the conditions under which milk and cream are handled on the farm and at the creamery, the effect of a cream-grading system upon the quality of cream delivered, the fuel cost of creameries, and the cost of the different operations in the manufacture of butter.

Location.—Washington, D. C., Grove City, Pa., and creameries throughout the United States.

Date begun.—1906.

Results.—Information has been gathered showing the conditions under which dairy products are handled from the production of the milk to the marketing of the butter. The effect of the use of a cream-grading system under certain conditions has been determined. Some data have been gathered showing the cost of fuel and of different operations in the manufacture of butter. Publications issued: B. A. I. Circular 126, "A Simple Method of Keeping Creamery Records"; B. A. I. Bulletins 148, "The Manufacture of Butter for Storage," and 149, "The Normal Composition of American Creamery Butter."

Assignment.—S. C. Thompson, M. P. A. Sondergaard, W. B. Thurston, J. C. Joslin.

Proposed expenditures, 1916-17.—\$6,500.

Cheese Factory Investigations:

Object.—To determine in what districts it would be feasible to encourage the manufacture of cheese, what is being done in the manufacture of cheese in districts other than the cheese centers, and particularly what kinds of cheese can be successfully and profitably manufactured in certain sections of the South; to secure data relative to methods used in the best managed factories; to determine what machinery is most efficient for cheese factories.

Procedure.—Data are secured from reports by cheese factories in different sections of the country. Representatives visit localities where cheese might be produced and endeavor to stimulate an interest in this industry. Studies are being made of equipment and methods of operating cheese factories.

Location.—United States.

Date begun.—1915.

Results.—Data have been gathered on the cost of making cheese, and the cheese-making possibilities of the mountainous sections of the South and of the Rocky Mountain States have been studied.

Assignment.—C. F. Doane, E. L. Chaplin.

Proposed expenditures, 1916-17.—\$3,500.

[Regulation.]

Renovated-Butter Inspection:

Object.—To carry on the inspection of renovated butter, the materials used in its manufacture, and factories producing this product, as required by the act of May 9, 1902.

Procedure.—At the plants where the inspection is done by Bureau of Animal Industry lay inspectors both the factory and the products are inspected frequently. Where no such inspectors are stationed, about three inspections are made each month. The chief inspector has general supervision of the inspection. The work is done according to regulations issued jointly by the Secretary of the Treasury and the Secretary of Agriculture under dates of July 11, 1907, September 30, 1908, October 23, 1911 (B. A. I. Order 147 and amendments 1 and 2 thereto, and supplement to amendment 1, and B. A. I. Order 193).

Location.—United States.

Date begun.—1902.

Results.—Factories are inspected at intervals by two regular renovated-butter inspectors and about 20 bureau lay inspectors. A sanitary condition of the factories and product is maintained. Compliance with the regulation regarding the marking of renovated-butter packages is required.

Assignment.—T. Corneliuson, M. W. Lang.

Proposed expenditures, 1916-17.—\$7,400.

Butter Inspection for Navy Department:

Object.—To assist the Navy Department in securing first-class tinned and tub creamery butter and to study the manufacture of butter for storage.

Procedure.—Inspectors are stationed at the plants where butter for storage is packed for the Navy. These inspectors daily ascertain that both the raw material and the finished product comply with the requirements of the specifications. One man has general supervision of this work at all the plants.

Cooperation.—The Navy Department bears the expenses of the special inspectors and furnishes samples of butter for examination and analysis.

Location.—At creameries throughout the United States securing contracts for Navy butter.

Date begun.—1902.

Results.—A marked improvement in the quality of the butter obtained as compared with the quality of butter of former years. Sweet cream is churned and the deterioration in quality is small. Nearly 1,000,000 pounds are inspected annually.

Assignment.—T. Corneliuson.

Proposed expenditures, 1916-17.—\$1,000.

Total, Dairy Manufacturing, \$53,525, including \$3,155 statutory (extension \$30,625; research, \$13,600; regulation, \$9,300).

[Research.]

DAIRY RESEARCH LABORATORIES.

Supervision:*Object.*—General supervision and office work of laboratories.*Location.*—Washington, D. C.*Date begun.*—1902.*Assignment.*—L. A. Rogers.*Proposed expenditures, 1916-17.*—\$6,960.**Investigations of the Manufacture and Handling of Commercial Ice Cream:***Object.*—To determine methods and conditions necessary for the practical, economical, and sanitary manufacture of ice cream.*Procedure.*—The bacteriology of the raw materials entering into the product and the influence of these bacteria on the flavor and their value as an indication of insanitary conditions are studied. Studies are also made of the use of pure cultures in developing desirable flavors and of the influence of various constituents on the flavor and physical characters of the product, ice cream being manufactured on a laboratory scale to facilitate the investigation. The application of principles so established to practice will be determined by work on a commercial scale.*Cooperation.*—Private individuals who manufacture ice cream.*Location.*—Washington, D. C.*Date begun.*—1912.*Results.*—The numbers and kinds of bacteria which may be expected in commercial ice cream have been determined; influence on the flavor of a number of the usual constituents of ice cream determined; one paper has been published, Department Bulletin 303, "The Bacteriological Study of Retail Ice Cream."*Assignment.*—O. E. Williams, S. H. Ayers.*Proposed expenditures, 1916-17.*—\$2,660.**Changes in Butter:***Object.*—To determine the factors which control the flavor, both desirable and undesirable, of butter. This includes methods of handling cream, pasteurization, ripening of cream, changes of butter in storage, and methods of renovating.*Procedure.*—A study of (1) the bacterial flora of cream under different conditions, the bacteria and yeasts of butter under normal conditions and as affected by different factors, such as the temperature and time of storage and the addition of antiseptics, and the relation of microorganisms to change in flavor; (2) the chemical changes in butter, the factors which control them, and the relation of these changes to the changes in flavor of the butter; and (3) the effect of various creamery practices on the flavor of the butter and on the nature of the changes in storage.*Location.*—Washington, D. C., and Grove City, Pa.*Date begun.*—1902.*Results.*—Bacteria are not a factor in the ordinary deterioration of butter. Factors increasing the rate of change are high acidity of cream, presence of metal salts, increased acid in butter, and high storage temperature. The principal cause of change in flavor is an oxidation of the nitrogenous constituents, in which nearly all the oxygen of the air inclosed in the butter is consumed. By eliminating many of these factors it is possible to make butter of exceptional keeping quality. Publications issued: B. A. I. Bulletins 57, 84, 89, 114, 148, 149, and 162 and B. A. I. Circulars 100, 130, 146, 189, and 200.*Assignment.*—D. C. Dyer, L. A. Rogers.*Proposed expenditures, 1916-17.*—\$7,305.**Milk-Condensing Investigations:***Object.*—To secure a general knowledge of milk condensing; to determine causes of spoilage and develop logical methods of operation.*Procedure.*—Chemical and bacteriological studies on normal and abnormal milk and condensing experiments on a small scale are made. All new methods will be tested on a commercial scale in the experimental creamery.*Location.*—Washington, D. C., and Grove City, Pa.*Date begun.*—1914.

Milk-Condensing Investigations—Continued.

Results.—A survey of the methods of condensing in this country has been made and equipment installed for condensing on a laboratory and a commercial scale.

Assignment.—G. A. Menge.

Proposed expenditures, 1916-17.—\$4,480.

Bacteriology of Milk:

Object.—To acquire complete and detailed knowledge of the bacteria occurring in milk, their relation to one another and to similar groups occurring elsewhere, their physiology and action on the constituents of milk, their habitat and the means by which they get into milk, and methods of preventing contamination and means of destroying bacteria in milk.

Procedure.—Biological studies will be made of particular groups, as, for instance, the morphology, temperature limitations, food requirements, and natural habitat of the group of bacteria giving an alkaline reaction in milk. Similar studies will be made on the lactic-acid bacteria, the colon group, the bacteria inhabiting the udder of the cow, and other types of bacteria. The groups of bacteria established by these studies will be compared with similar bacteria found under natural conditions, and the means by which they are transmitted from their natural habitat to milk will be traced. Facilities for this work will be available at the Beltsville farm. Methods of destroying bacteria in milk will be determined by laboratory studies of pasteurization, action of ultra-violet rays, etc. This includes a study of the bacteria surviving pasteurization, the limits of heat which may be used as determined by changes in the milk, and the most efficient methods of pasteurization. It will be necessary at times to work on a commercial scale in city milk plants.

Location.—Washington, D. C., and Beltsville, Md.

Date begun.—1905.

Results.—Much exact information has been obtained on the biology of various groups of bacteria, particularly the colon group, the streptococci and the alkali-forming group, their relative numbers in milk, and their origin. The bacteriological and chemical changes which occur when milk is pasteurized have been determined and a new and efficient method of pasteurization established. Data in Department Bulletins 240 and 342, and in numerous papers published in scientific journals.

Assignment.—S. H. Ayers, Philip Rupp, W. T. Johnson, P. W. Clemmer, L. A. Rogers, W. M. Clark.

Proposed expenditures, 1916-17.—\$7,760.

Physiology of Milk Secretion:

Object.—To obtain definite knowledge of the mechanism of milk secretion and of the factors which control or influence this function, with a view to a more logical breeding and feeding of dairy cows.

Procedure.—A study is being made of the differences in the composition of the blood of the lactating and nonlactating cows. The subsequent procedure will depend on the result of this investigation.

Location.—Beltsville, Md.

Date begun.—1915.

Results.—Results of previous work on a similar project are published in B. A. I. Bulletins 111, 134, 155, 156, and 157 and in papers on carotin and lactochrome.

Probable date of completion.—1918.

Assignment.—E. B. Meigs, N. R. Blatherwick.

Proposed expenditures, 1916-17.—\$5,380.

Utilization of Creamery and Cheese-Factory By-Products:

Object.—To study methods for the utilization of by-products of creameries and cheese factories by converting them into products which will be useful in the arts or available as food for man or animals.

Procedure.—Chemical studies will be made of by-products and of the products into which they may possibly be converted. This will include investigations of new products and methods for their manufacture. At the experimental creamery skimmed milk will be condensed by various methods for ice-cream makers, bakers, and confectioners or converted into casein, milk sugar, albumen, etc. Attempts will be made to convert whey from cheese or casein manufacture into milk sugar or a flour for cooking purposes. When the practicability of a method has been established it will be applied on a commercial scale in order to determine the cost of production and the profits of manufacture.

Cooperation.—Bureau of Standards,

Utilization of Creamery and Cheese-Factory By-Products—Continued.*Location.*—Washington, D. C., and Grove City, Pa.*Date begun.*—1912.*Results.*—An investigation into the manufacture of casein has shown that the qualities of buttermilk casein which make it inferior to skimmed-milk casein for paper making are its higher ash and fat content. A method of manufacture has been devised by which these faults can be corrected and a casein obtained which is apparently equal to skimmed-milk casein.*Assignment.*—Man to be appointed.*Proposed expenditures, 1916-17.*—\$2,680.**Disposal of Dairy, Creamery, and Cheese-Factory Wastes:***Object.*—To provide means for the proper disposal of the wastes of dairy farms, creameries, and cheese factories.*Procedure.*—Experimental sewage-disposal plants will be installed on the dairy farm at Beltsville, Md., and at the experimental creamery at Grove City, Pa. The condition of the effluent and the cost of operation of these plants will be observed and modifications made as required. On the basis of the results obtained with these plants designs will be made for sewage-disposal plants for dairy farms, creameries, and cheese factories.*Cooperation.*—Hygienic Laboratory, Public Health Service, and Office of Public Roads and Rural Engineering.*Location.*—Grove City, Pa., and Beltsville, Md.*Date begun.*—1915.*Results.*—An experimental sewage-disposal plant has been installed at the creamery at Grove City, Pa.*Probable date of completion.*—1918.*Assignment.*—L. A. Rogers.*Proposed expenditures, 1916-17.*—\$500.**Manufacture and Ripening of Swiss Cheese:***Object.*—To acquire complete and detailed knowledge of the factors producing the peculiar chemical and physical changes which give Swiss cheese its desirable character, and to apply this knowledge to practice.*Procedure.*—Studies of the bacteria of normal and abnormal Swiss cheese and the relation of these bacteria to flavor and eye formation will be made. Chemical studies will be made of the changes which take place in ripening cheese and the relation of these changes to flavor and physical condition. Studies will be made of the methods of manufacture, conditions of ripening, and other factors which control proper fermentation.*Cooperation.*—Swiss-cheese factories in the United States.*Location.*—Washington, D. C.*Date begun.*—1907.*Results.*—Chemistry and physics of eye formation worked out; bacteriological factors controlling the initial fermentation determined and method developed for applying this in practice, so that it is possible to eliminate much of the objectionable gassy fermentation; sufficient progress made to make possible the control of the ripening of the cheese by the use of bacterial cultures and thus extend Swiss-cheese making to any section or any season in which good milk can be obtained. Publications: B. A. I. Bulletin 151, Department Bulletin 148, and two papers in scientific journals.*Probable date of completion.*—1918.*Assignment.*—C. F. Doane, W. M. Clark, H. A. Lubs, H. M. Jones, H. C. Jordan.*Proposed expenditures, 1916-17.*—\$8,500.**Soft-Cheese Investigations:***Object.*—To study the making and ripening of certain European varieties of soft cheese. This involves (a) a detailed study of the microorganisms active in their production; (b) the chemical determination of standards of composition with the complex changes involved in the ripening processes as applied to American milk and to the different climatic conditions encountered.*Procedure.*—This work involves the culture of bacteria and molds met in the making and ripening of the different varieties, their identification and comparison with related species, and the determination of their relation to the changes found. Chemical analyses of the cheese will be made at every stage of production; also enzymic studies of the separate changes found to occur, with analyses of the products of such change. Experimental manufacture will be carried on, beginning with the use of the foreign procedures of making and handling, and involving such alterations in the process as results from time to time may indicate to be desirable.

Soft-Cheese Investigations—Continued.*Location.*—Washington, D. C.*Date begun.*—1906.*Results.*—The factors essential to the manufacture and normal ripening of Camembert cheese have been established. A method has been developed for making a cheese of the Roquefort type from cow's milk. Publications: B. A. I. Bulletins 71, 82, 98, 109, 115, 118, and 120, and Circular 145, Storrs (Conn.) Experiment Station Bulletins 78 and 79, and four papers published in scientific journals.*Assignment.*—J. N. Currie, Alice C. Evans, K. J. Matheson, F. C. Cammack.*Proposed expenditures, 1916-17.*—\$7,110.**Cheddar-Cheese Investigations:***Object.*—To study methods of securing a more uniform product, the extent of losses and means of prevention, and bacteriological and chemical factors involved in the development of desirable and undesirable flavors.*Procedure.*—Chemical and bacteriological studies and manufacturing experiments on a small scale will be carried on in laboratories at Washington. For example, the use of starters in suppressing undesirable fermentations and the influence of different types of bacteria on the characteristic flavor will be investigated. More extensive improvements in cheese making will be conducted in factories under temporary contracts.*Cooperation.*—Cheese factories.*Location.*—Washington, D. C.*Date begun.*—1905.*Results.*—Experiments on the storage of cheese have been carried on in cooperation with the Wisconsin and New York (Geneva) agricultural experiment stations. From 1905 to 1909 manufacturing and storage investigations were carried on at factories in Wisconsin. From 1906 to 1914 cooperative work was carried on at the Wisconsin station on chemical and bacteriological changes in the ripening of Cheddar cheese and on methods of manufacture from pasteurized milk. This cooperative work was discontinued in 1914, and since that time the Cheddar-cheese work has been limited to an investigation of the practicability of ripening cheese in an hermetically sealed can. Publications: B. A. I. Bulletins 62, 85, 122, 123, 150, and 165, Circulars 166, 181, and 210, and Journal of Agricultural Research, vol. 2, No. 3.*Assignment.*—C. F. Doane.*Proposed expenditures, 1916-17.*—\$300.**Silage Investigations:***Object.*—To study the changes which take place in the material put into the silo.*Procedure.*—Chemical studies of silage made and preserved under known conditions will be conducted to determine the changes taking place in the silo at various stages of maturity.*Location.*—Washington, D. C.*Date begun.*—1912.*Results.*—No difference has been observed in the chemical composition or appearance of the silage from wooden or concrete silos. The loss in total weight and in food constituents has been determined in silage from the two kinds of silos. Present work has principally to do with (a) the nitrogen and other losses during the curing process, and (b) the action of silage juice on concrete of different compositions.*Assignment.*—R. H. Shaw, E. F. Deysher, P. A. Wright.*Proposed expenditures, 1916-17.*—\$2,460.**Chemical Investigations in the Feeding of Dairy Cattle:***Object.*—To do the chemical work in connection with the feeding experiments conducted at Beltsville, Md.*Procedure.*—Analyses are made of the feeding stuffs to determine their composition, digestibility, etc.*Location.*—Washington, D. C.*Date begun.*—1914.*Results.*—Analyses have been made of the materials used in the feeding experiments, and the digestibility of these feeds has been determined. An investigation on the effect of water in the ration on the chemical composition of milk has been conducted and the results were published in the Journal of Agricultural Research, vol. 6, No. 4. Another investigation concerning the effect of mineral matter in the ration has been completed.*Assignment.*—R. H. Shaw, E. F. Deysher, P. A. Wright.*Proposed expenditures, 1916-17.*—\$2,510.**Total, Dairy Research Laboratories, \$58,605, including \$4,260 statutory.**

MILK INVESTIGATIONS AND DEMONSTRATIONS.

Supervision:

Object.—To supervise the work of the section, answer correspondence, etc.

Location.—Washington, D. C.

Date begun.—1900.

Assignment.—Ernest Kelly.

Proposed expenditures, 1916-17.—\$3,025 (extension, \$1,765; research, \$1,260).

[Research.]

Dairy Sanitation Investigations:

Object.—To study the sanitation of city milk supplies, investigate factors influencing the commercial quality of milk, and devise means for producing and handling milk of a superior quality.

Procedure.—Studies are made of farms supplying milk to cities throughout the country, and of plants handling milk in the cities, with a view to discover efficient methods and equipment. A large number of milk and cream samples are studied to note the effect of various operations on the bacterial content of milk and the effect of certain feeds on the flavor of milk.

Cooperation.—State and municipal boards of health and dairymen.

Location.—United States.

Date begun.—1900.

Results.—Data on the extra cost of producing clean milk, the milk supplies of Chicago and Washington, the control of bulk milk in stores, and the work of medical milk commissions published in B. A. I. Circulars 170 and 217, and Bulletin 138 and Department Bulletin 1.

Assignment.—Ernest Kelly, L. B. Cook, J. A. Gamble, R. S. Smith, G. B. Taylor.

Proposed expenditures, 1916-17.—\$2,960.

Cost of Handling Milk:

Object.—To determine the cost of handling milk in cities, including the cost of various operations in preparing milk for the market; to discover uneconomical methods and suggest ways of lessening the cost of handling.

Procedure.—Surveys are made of milk plants in various cities to obtain the desired information. A cooperative agreement exists between this bureau and the Office of Markets and Rural Organization regarding this work.

Cooperation.—Office of Markets and Rural Organization; milk dealers.

Location.—United States.

Date begun.—1912.

Results.—Surveys have been made of nearly 100 milk plants. A large mass of data has been gathered dealing with investment, labor, organization, and various other items. The results of these investigations have been brought to the attention of milk dealers by means of monthly circular letters. Assistance has been given to milk dealers in planning and equipping their plants. A study made of the milk supply of Detroit, Mich., included the cost of transporting milk from the producer to the consumer. An article on "The City Milk Plant" has been prepared.

Assignment.—C. E. Clement.

Proposed expenditures, 1916-17.—\$2,690.

Cost of Milk Production:

Object.—To ascertain the actual cost of milk production on the average dairy farm; to learn the increased cost of milk production attributable to modern sanitary methods and the variation in cost of milk production in different sections.

Procedure.—Field agents will be employed in three or four States, who will make observations on a group of dairy farms to ascertain the various costs connected with milk production.

Cooperation.—North Carolina Experiment Station and extension department of the Indiana College of Agriculture.

Location.—North Carolina and Indiana; possibly one other State.

Date begun.—1914.

Results.—Detailed records of the cost of milk production have been kept on 15 farms in North Carolina and 20 farms in Indiana.

Probable date of completion.—1918.

Assignment.—J. B. Bain.

Proposed expenditures, 1916-17.—\$6,700.

[Extension.]

Dairy Sanitation Extension:

Object.—To carry on educational work among dairymen and milk handlers and to unify and make more efficient inspections conducted by State and municipal boards of health.

Procedure.—This work is done almost exclusively in cooperation with the State and municipal boards of health. Visits are made to cities at the request of the proper authorities and inspectors instructed in an efficient system of dairy and milk inspection.

Cooperation.—State and municipal boards of health and State dairy commissioners.

Location.—United States.

Date begun.—1900.

Results.—Many city milk supplies have been greatly improved from a sanitary standpoint. A large number of health departments have inaugurated an efficient and systematic control of milk supplies. Publications: B. A. I. Circular 199, Department Bulletin 356, and Farmers' Bulletins 602 and 689.

Assignment.—Ernest Kelly, L. B. Cook, J. A. Gamble, R. S. Smith, G. B. Taylor.

Proposed expenditures, 1916-17.—\$13,000.

Total, Milk Investigations and Demonstrations, \$28,375, including \$725 statutory (extension, \$14,765; research, \$13,610).

[Research.]

DAIRY DIVISION EXPERIMENT FARM.**Supervision:**

Object.—Supervision of all work in dairying at the dairy experiment station.

Procedure.—A farm superintendent supervises all the work of the farm, including experimental investigations.

Location.—Beltsville, Md.

Date begun.—1910.

Assignment.—T. E. Woodward.

Proposed expenditures, 1916-17.—\$7,360.

Breeding of Dairy Cattle:

Object.—To study the breeding of dairy cattle and to apply such principles of breeding as are established.

Procedure.—The dairy herd that is being developed at the Beltsville station will be used for this purpose. Part of this study will be made with pure-bred cattle and part with grade cattle. The grade cattle will be used for determining the practicability of inbreeding for one generation. Two breeds will be used at the Beltsville station for this work. Later it is proposed to arrange with a number of farmers to carry on similar breeding under the supervision of the leader of this work. The study of pure-bred cattle will relate to the various systems of breeding upon productivity, vigor, prepotency, etc.

Location.—Beltsville, Md.

Date begun.—1912.

Results.—Thus far the only work done has been with grade cattle. Twenty-three grade cows are now being bred according to this plan. Thirty heifer calves from the first mating are on hand. These heifers have every indication of being greatly superior to their dams. Ten have been bred back to their sire, and there has been one calf of the second generation.

Assignment.—T. E. Woodward.

Proposed expenditures, 1916-17.—\$6,000.

Feeding of Dairy Cattle:

Object.—To ascertain the effects of the various feeds and constituents of feeds upon the animal body, upon growth, and upon the yield and composition of milk; to find out the relative values of feeds for dairy production.

Procedure.—All the dairy animals on the Beltsville farm will be used for experimental work. Feeds and constituents of feeds of known composition will be fed selected animals in definite amounts and for stated periods. The results are measured in one or more of several ways, depending on the nature of the particular experiment, such as palatability and digestibility of the food, health, vigor, and growth of the animals, production of milk and fat, and the composition and flavor of the dairy products. Chemical analyses of the feed and the product, and in some cases of the excreta also, are required.

Location.—Beltsville, Md.

Date begun.—1913.

Feeding of Dairy Cattle—Continued.

Results.—Sour skimmed milk, when properly used, was found to be a good feed for young calves. Withholding a portion of the water normally consumed by cows had no influence upon the composition of the milk produced. Bone meal added to the ration exerted no influence upon the composition of the milk. In cooperation with the market milk section, it was found that beet pulp injured the flavor of the milk. This was especially noticeable when milk was allowed to stand for several days. It has been demonstrated that the flavor and odor of milk and cream are influenced decidedly by exposure to silage odors. The value of prickly pear as a feed for dairy cows has been determined, and the results published in the *Journal of Agricultural Research*, vol. 4, No. 5, "Prickly Pears as a Feed for Dairy Cows." Dried fish meal, a by-product from the sardine canning industry, although somewhat unpalatable, was found to increase the yield of milk but to cause a decrease in the percentage of fat. Potato meal and potato silage were found to be palatable enough to warrant further investigations. Feeding tests indicate that cottonseed meal fed to young calves has a permanent poisonous effect. The addition of certain compounds of iron to the cottonseed-meal ration exerted little beneficial effect. Cornstalk extract, a by-product in the manufacture of paper from cornstalks, was found to have a feeding value amounting to 37 per cent of that of a standard grain mixture.

Assignment.—W. R. Hale.

Proposed expenditures, 1916-17.—\$4,640.

Housing and Care of Dairy Cattle:

Object.—To determine the best method of stabling cows; to investigate problems in the milking and care of cows and in herd management.

Procedure.—The cattle will be housed and cared for under different conditions and the results measured in one or more of several ways, such as health and vigor of the herd, growth, production, economy of feeding, operation and construction, and sanitation of the milk.

Location.—Beltsville, Md.

Date begun.—1912.

Results.—It has been demonstrated that a shed open on the south is a successful method of housing dairy cattle. It keeps the cows clean and healthy and provides for the saving and storage of manure in an efficient manner. It seems to be especially adapted for the housing of young stock. The effect of the southern cattle tick upon milk production and body weight of dairy cows has been published in Department Bulletin 147, "The Effect of the Cattle Tick upon the Milk Production of Dairy Cows." Cooperative work with the Dairy Division laboratories has shown that milk with a low bacteria count can be produced under average farm conditions provided that ordinary care is exercised in keeping the cows and stable clean and that the utensils are properly sterilized with steam.

Assignment.—W. R. Hale.

Proposed expenditures, 1916-17.—\$2,780.

Feed Production:

Object.—Primarily, to produce feed for the dairy herd. Detailed records are kept of the cost of all farm operations and observations made on the building up of the soil by fertilization, tillage, and drainage.

Procedure.—About 170 acres of the Dairy Division Experiment Farm are tillable, and all of this area is devoted to the growing of crops for the dairy cattle and for the maintenance of work stock. Detailed records are kept of the cost of all operations.

Cooperation.—Bureau of Soils and Office of Public Roads and Rural Engineering.

Location.—Beltsville, Md.

Date begun.—1910.

Results.—The land has been cleared, ditches filled, 36,000 feet of draitile laid, the roads through the farm and around the buildings graded and surfaced, and grading done around the buildings. The productivity of the land has been greatly increased by the application of manure and lime and by a systematic rotation of crops. All of the silage and most of the hay required for feeding the dairy herd and the work stock for the farm is being grown on the farm. It has been found that land can be plowed to a depth of 8 inches with a 15-30 horsepower tractor at an average cost of \$1.12 per acre. Similar land plowed to the same depth with a walking plow and two mules was found to cost \$1.43 per acre.

Assignment.—T. E. Woodward.

Proposed expenditures, 1916-17.—\$7,690.

Silage Investigations:

Object.—To determine the advantages and disadvantages of the various materials used in building and preserving silos, find the stage of maturity at which the corn plant should be siloed, and try siloing various farm crops.

Procedure.—A comparison will be made of different materials used in silo construction. Changes taking place in the silo with crops at various stages of maturity will be noted, in order to learn the best time of harvesting.

Cooperation.—Office of Public Roads and Rural Engineering.

Location.—Beltsville, Md.

Date begun.—1912.

Results.—There was found to be no practical difference between the silage made in the concrete silo and that made in the wooden silo, although the temperatures during fermentation ran uniformly several degrees higher in the wooden silo. Either kind of silo will preserve the contents perfectly, and there is no marked difference in the losses occasioned by fermentation. Thick-planted corn yielded a greater tonnage than thin-planted corn. Corn yielded heavier than sweet sorghum. Corn which is almost dead ripe can be siloed successfully if sufficient water is added and care is exercised in packing at the time the silo is filled. Data in Farmers' Bulletin 578, "The Making and Feeding of Silage."

Assignment.—T. E. Woodward, W. R. Hale.

Proposed expenditures, 1916-17.—\$1,190.

(Construction of Buildings: This project has been combined with projects under Animal Husbandry Investigations and Investigations of Animal Diseases, covering building operations at the bureau experiment stations; work reported under the title "Construction of Buildings at Bethesda and Beltsville.")

Total, Dairy Division Experiment Farm, \$29,660, including \$2,640 statutory.

[Research.]

METABOLISM IN DAIRY COWS.**Metabolism in Dairy Cows:**

Object.—To determine the total energy of the feed consumed by milking animals, the losses of energy in the excreta, the expenditure of energy consequent upon the consumption of the feed and, by difference, the net energy of the feed; to determine the distribution of this net energy of the feed between the two possible forms of production, viz, fattening or milk secretion, and the effect upon it of the quantity and quality of the feed, as well as of other factors.

Procedure.—(1) Determine the maintenance requirement of the dry animal.

(2) Feed a moderate ration and by means of successive respiration calorimeter experiments trace the variations in the distribution of net energy between milk production and body gain with advancing lactation. In this way it is hoped to determine the quantitative relation between the two forms of production.

(3) Study the effect of varying amounts of the same combination of feeding stuffs in increasing the milk production on the one hand and the body gain of the animal on the other hand. (4) Study the effect upon milk production and body gain of substituting protein for carbohydrates, and vice versa, in rations otherwise identical.

Cooperation.—Animal Nutrition Institute of Pennsylvania State College.

Location.—State College, Pa.

Date begun.—1915.

Results.—Three respiration calorimeter experiments have been successfully carried out on three cows in milk, each receiving throughout the experimental period a ration uniform in quantity and quality. The data obtained are now being compiled.

Assignment.—H. P. Armsby, State College, Pa.

Proposed expenditures, 1916-17.—\$3,500.

[Extension.]

WESTERN DAIRY EXTENSION.**Supervision:**

Object.—General supervision of western dairy extension work, including clerical work, general correspondence, etc.

Location.—Salt Lake City, Utah.

Date begun.—1911.

Assignment.—J. E. Dorman.

Proposed expenditures, 1916-17.—\$4,800.

Dairy Farming:

Object.—To improve and develop the business of dairying in the Western States.

Procedure.—Cooperative field agents will be appointed to instruct farmers in feeding dairy cows, raising calves, and in the construction of silos and dairy buildings. Herd-record work will be introduced and advice given in the selection of pure-bred bulls. An endeavor will be made to improve the quality of dairy products, work will be taken up with rural schools, and aid given to county agents in handling their dairy problems.

Cooperation.—Extension departments of the agricultural colleges in the States named under "Location."

Location.—Washington, Oregon, Idaho, Montana, Wyoming, Nevada, Utah, and New Mexico.

Date begun.—1908.

Results.—One section in Idaho has purchased 4,000 dairy cows. Seventeen cow-testing associations and 5 bull associations have been formed, and a large number of dairymen are keeping records of the production of their cows. A number of schools have conducted dairy-herd record contests with the assistance of the field men. In 1915 assistance was given in the building of 187 silos and 7 dairy barns. The saving to the farmers on these barns was approximately \$2,000 on each barn. Plans were furnished for 70 dairy buildings and assistance given to county agents in their dairy problems. A rapid dairy development has taken place in a number of counties. Several publications have been prepared by the dairy field agents and issued by the colleges cooperating.

Assignment.—J. E. Dorman, Salt Lake City, Utah.

Proposed expenditures, 1916-17.—\$20,150.

Milk Work:

Object.—To carry on educational work among dairymen and milk handlers, and to unify and make more efficient inspections carried on by State and municipal boards of health.

Procedure.—This work is done almost exclusively in cooperation with the State and municipal boards of health. Visits are made to cities at the request of the proper authorities and inspectors instructed in an efficient system of dairy and milk inspection.

Cooperation.—State and city boards of health.

Location.—Western United States.

Date begun.—1912.

Results.—Milk and cream contests have served to point out defective methods of production; nine milk and cream contests conducted last year and 1,034 samples of milk scored. Practically all the cities in the Western States now use the Government score card for the scoring of dairies. During the past year assistance was given local authorities in the inspection of dairies in the following cities: Helena and Butte, Mont., Salt Lake City and Ogden, Utah, Spokane, Tacoma, and Everett, Wash., Oakland, Cal., Salem, Oreg., and Reno, Nev. Complete economic surveys were made of several milk plants. Plans for city milk plants and dairy buildings were furnished to a number of dairymen. Two cities were assisted in the drafting of milk ordinances, and assistance was given to four State departments on milk questions.

Assignment.—J. E. Dorman.

Proposed expenditures, 1916-17.—\$3,420.

Dairy Manufacturing:

Object.—To carry on educational work for the purpose of introducing better methods and securing a uniformly good product.

Procedure.—Assistance is given to creameries and cheese factories where needed. Assistance is also given in the organization of creameries and cheese factories in localities having a sufficient number of cows. Butter-scoring contests are conducted and help extended through correspondence.

Cooperation.—Creameries and cheese factories in Washington, Oregon, Idaho, Montana, Wyoming, Nevada, Utah, and New Mexico.

Location.—Western United States.

Date begun.—1912.

Dairy Manufacturing—Continued.

Results.—Creamery conditions were found to be bad, poor records kept, and the quality of butter very variable. During the past year assistance has been given by correspondence and personal visits to 98 creameries and 20 cheese factories. As a result one creamery received 2 to 3 cents more for its product and returned \$7,000 more to its patrons on this account. Twenty creameries have introduced pasteurization. Three cooperative creameries and two cooperative cheese factories were organized. Fourteen butter and cheese contests were held and one students' butter-judging contest conducted. Creameries have been induced to keep records of their operation and make moisture tests, and, through the Office of Markets and Rural Organization, their products have been marketed to better advantage. A pamphlet has been issued on "Creamery Accounts."

Assignment.—G. E. Frevert.

Proposed expenditures, 1916-17.—\$3,420.

Total, Western Dairy Extension, \$31,790, including \$1,200 statutory.

Total, Dairy Investigations, \$303,270, including \$25,800 statutory (research, \$148,130; extension, \$143,840; regulation, \$11,300).

ANIMAL HUSBANDRY INVESTIGATIONS.**ADMINISTRATION.****Administration:**

Object.—To provide for the general administration of the work in the Animal Husbandry Division. Such office expenses as are not directly chargeable to specific projects come under this head.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—George M. Rommel.

Proposed expenditures, 1916-17.—\$18,080, including \$6,880 statutory (research, \$10,000; extension, \$7,500; regulation, \$580).

[Research.]

ANIMAL GENETICS.**Genetic Research:**

Object.—To obtain as complete an understanding as possible of the effects of inbreeding from a scientific standpoint; the interpretation of these results with regard to advantages and disadvantages in practical breeding, with suggestions as to the mode of procedure to secure the former without suffering from the latter; to obtain an understanding of the mode of inheritance of special traits; and, in general, to obtain an understanding of the factors which determine the course of the life histories of animals.

Procedure.—Guinea pigs have been inbred, brother and sister, for as many as 16 generations. Numerous matings of unrelated individuals have been made as controls, and matings are being made between individuals of different highly inbred families. The life histories and the inheritance and development of special traits are being compared, detail for detail, in animals from these three types of matings.

Location.—Washington, D. C., and Beltsville, Md.

Date begun.—1906.

Results.—(1) During 1916: A reanalysis of the enormous mass of data is in progress at present.

(2) Prior to 1916: Work on the project was begun in June, 1906, and complete records of the experiment up to June, 1913, are on file. A discussion of the results would be premature, beyond a statement that the mere fact that guinea pigs can be inbred, brother and sister, for 16 generations, with no very obvious degeneration, demonstrates that the evils of inbreeding are by no means as great as has often been held.

Assignment.—Sewall G. Wright.

Proposed expenditures, 1916-17.—\$6,560, including \$900 statutory.

(Close Breeding of Animals: Superseded by project "Genetic Research.")

[Research.]

ANIMAL HUSBANDRY EXPERIMENT FARM.

Animal Husbandry Experiment Farm:

Object.—To furnish facilities for the continuation of investigations in the feeding and breeding of farm animals, including poultry.

Procedure.—A senior animal husbandman is in charge of the farm and ranks the same as those in charge of definite projects of investigational work, although he has no direct connection with any research work.

Location.—Beltsville, Md.

Date begun.—1910.

Results.—(1) During 1916: An abattoir, poultry house, and two sheep sheds have been constructed during the past year. Field crops have been put in, and a sewage system and a system of drainage are being installed. It is desirable to erect cottages for the employees and a hospital building.

(2) Prior to 1916: Since the farm was started 11 buildings have been erected and roads built. No animal husbandry results are expected from the farm *per se*; results are obtained under the direction of men in charge of other projects.

Assignment.—E. L. Shaw.

Proposed expenditures, 1916-17.—\$19,480, including \$1,480 statutory.

BEEF-CATTLE INVESTIGATIONS.

Supervision:

Object.—The general supervision of the work in beef-cattle investigations, correspondence, and maintenance of record files pertaining to same.

Location.—Washington, D. C.

Date begun.—1904.

Assignment.—W. F. Ward.

Proposed expenditures, 1916-17.—\$5,000 (research, \$4,000; extension, \$1,000).

[Research.]

Beef Production:

Object.—To study the cost of maintaining breeding herds and the cost of producing beef animals to various ages; to study methods of fattening cattle and the relative importance of various feedstuffs for such purpose, including work with calves, baby heaves, and steers; to study methods of wintering stocker and feeder cattle; and to determine the effect of beef-cattle raising on soil fertility.

Procedure.—The work will be conducted upon farms especially selected for the purpose, the owners of which will furnish all cattle, pasture lands, feed lots, sheds, and other equipment necessary for the proper conduct of the experiments, except in such cases where it is agreed that the colleges shall furnish a part of the equipment. An assistant in animal husbandry will be placed upon each farm to supervise and carry out the proposed experimental work. Herds of breeding animals will be maintained for studying the cost of producing calves, yearlings, etc., and for determining economical methods of wintering the herd. Other cattle will be used in the winter-feeding and summer-feeding experiments, both for the maintenance of stockers and feeders and the fattening of various classes of animals for the market. Complete records will be kept showing the amounts of feed consumed by each lot, the weights and gains, the cost of production, and all other data which may be of value in the study of these questions.

Cooperation.—Various agricultural colleges or experiment stations in the States where the work is to be conducted and private individuals owning the farms upon which the experiments will be made.

Location.—Washington, D. C., and the field.

Date begun.—1913.

Results.—(1) During 1916: Four lots of 20 steers each are being used at Canton, Miss., testing the comparative values of sorghum silage and corn stover, sorghum silage and oat straw, sorghum silage alone, and a mixture of home-grown roughages, cowpea hay, oat straw, and corn stover for fattening steers. The same grain ration is used for all lots. Fifty-two cows are being used in the breeding experiments.

Beef Production—Continued.

At Abbott, Miss., 3 carloads of steers, divided into 3 lots, are being used to test the comparative values of cottonseed meal alone, cottonseed meal and broken ear corn, and cottonseed meal and shelled corn for finishing steers for the market. The same roughage is used for all lots. Three lots of calves are being finished out as baby beefs to test the efficiency of cottonseed meal alone as compared with cottonseed meal and shelled corn, and shelled corn alone, as the grain ration for such animals. A herd of 75 breeding cows is being used in the experiments to determine the cost of producing beef calves in the prairie section of Mississippi.

At Springdale, N. C., 97 steers, divided into 4 lots, are being used in conducting experiments in wintering stocker steers which are to be fattened out on pasture the subsequent summer.

Three lots of steers are being used at Lewisburg, W. Va., to test three methods of wintering stocker steers, the prevailing method in that section being to winter the steers on dry roughage and some ear corn. The experiments show that this is the most expensive way of carrying steers through the winter. Larger daily gains and cheaper gains are made by steers which are wintered on silage and cottonseed meal. Three lots of breeding cows are being used in studying the cost of wintering the breeding herd.

(2) Prior to 1916: The Mississippi work is a continuation of the work started in cooperation with the Alabama Experiment Station in 1904, being transferred on June 1, 1914, to the present location in order that it might be carried on in counties which had eradicated the cattle tick. Reports of the southern beef-production work have been published in B. A. I. Bulletins 103, 131, 147, and 159 and Department Bulletins 73 and 110.

In North Carolina, during the winter of 1913, two lots of beef cattle were fed to compare corn silage with dry feed for fattening steers in the dry lot. Four other lots were used to study economical methods of wintering stocker cattle. During the summer of 1914 feeding on pasture was practiced, and during the winter of 1914-15 four lots of stocker cattle were used in comparing methods of wintering cattle. The use of uncut meadow for wintering cattle proved very economical and the steers wintered much better and for about three-fifths of the cost of steers in the dry lot with barn protection.

A live-stock survey was made of the principal stock-raising counties in West Virginia during 1914 to determine the status of the beef-cattle industry and to learn the weak points in the system of conducting live-stock work. During the winter of 1914-15 an experiment was conducted at Lewisburg, W. Va., to compare different methods of wintering yearling cattle. Those wintered on hay and wheat straw, the customary manner of wintering yearlings, lost 46 pounds each in weight and were wintered at a cost of \$9.21 each, while similar cattle fed on silage, cottonseed meal, and wheat straw gained 74 pounds each and cost but \$8.34 per head to winter.

Assignment.—W. F. Ward, G. A. Scott.

Proposed expenditures, 1916-17.—\$10,000.

(Beef Production in the South: Discontinued as a separate project; included under "Beef Production.")

(Beef Production in North Carolina: Discontinued as a separate project; included under "Beef Production.")

(Live-Stock Production in the Appalachian Region: Discontinued as a separate project; included under "Beef Production.")

Breeding Shorthorn Cattle:

Object.—By an experimental study with a breeding herd of Shorthorn cattle to secure information on the following points: (a) Is the milking tendency in beef cattle transmitted mainly by the dams through the male line of descent? (b) To what extent does the milk-giving function of the dam influence the beef character of the progeny? (c) By mating thickly fleshed beef bulls whose dams were heavy milkers and beef cows which transmit beef character to their progeny, is it possible to establish a heavy milking strain of beef cattle within a breed the female progeny of which will be double-purpose beef and milk animals and the males strictly of the beef type? In other words, is it possible to retain the typical beef form in the male animals and increase the milking tendency in the females? (d) Is the present standard of selecting beef cows conducive to the production of the best beef type in the breed?

Breeding Shorthorn Cattle—Continued.

Procedure.—Twenty Shorthorn cows will be purchased, each of which has shown her ability to transmit beef characteristics to her offspring. Only those cows which show signs of being good milkers will be selected. They will be placed upon the experimental farm of the Kansas Experiment Station at Manhattan, Kans., and will be bred to a Shorthorn bull that is an outstanding beef animal, whose dam was a heavy milker. The calves produced will be raised by nurse cows and by hand feeding, and the foundation cows will be milked and accurate records kept of their milk production and feed consumption. The heaviest milk-producing cow each year is to be bred to the champion beef bull of the country if he is from a heavy milking dam. The other cows in the herd will be bred to the herd bull maintained with the experimental herd. Heifers which prove to be good milkers will be kept to replace cows in the breeding herd. Some of the bull calves may be castrated and used for show purposes, while others may be loaned, rented, or sold to farmers who will agree to make a trial of their breeding value, and careful records will be kept upon their performance in this respect. Future herd bulls will be selected from the experimental breeding herd.

Cooperation.—Kansas Experiment Station.

Location.—Manhattan, Kans.

Date begun.—1915.

Results.—The work has not progressed sufficiently to be reported.

Assignment.—W. F. Ward, for the department; W. A. Cochel, for the Kansas Experiment Station.

Proposed expenditures, 1916-17.—\$5,000.

Shrinkage in Live Stock during Transportation:

Object.—To study the loss in weight of live stock in transit and the methods of improving conditions surrounding live-stock shipments.

Procedure.—Carload shipments are studied from starting point to destination and data compiled. It is proposed to continue these studies by using the work already done as a basis and study methods of handling and marketing both cattle and other shipments with a view to reduce the loss in weight to a minimum.

Cooperation.—Various railroad and stockyard companies throughout the country.

Location.—Washington, D. C., and the field.

Date begun.—1910.

Results.—The study of the loss in weight of beef cattle in transit covering the Southwest, Northwest, and the corn belt shows that cattle shrank in weight from 3 to 5 per cent from live weight under varying conditions. Shrinkage in hogs was found to be from one-half to 1½ per cent in weight at point of origin. These results are to be used for the information and advice of live-stock shippers so that they may realize the large loss resulting from this source.

Assignment.—W. F. Ward.

Proposed expenditures, 1916-17.—\$1,900.

[Extension.]

Beef-Cattle Extension Work:

Object.—By the organization of associations to improve beef cattle and the cooperative purchase and sale of breeding animals; to organize baby-beef clubs and bull clubs and give instructions to farmers by lectures and otherwise on matters of educational value in beef-cattle work; to conduct feeding experiments on individual farms for the purpose of demonstrating systems of feeding, management, etc.; in cooperation with the Office of Public Roads and Rural Engineering, to assist in planning and constructing more silos and better farm buildings and in giving demonstrations to farmers of a community on the methods of constructing such improvements; to give demonstrations on dehorning, castrating, vaccinating, and handling cattle on the farm in a practical and economical manner, including personal advice and assistance when possible; to distribute bulletins, circular letters, etc., and by personal visits or correspondence give assistance to farmers and live-stock men on all matters pertaining to beef-cattle work.

Beef-Cattle Extension Work—Continued.

Procedure.—County live-stock associations are being formed for the general upbuilding of the live-stock industry. Registered live stock raised by members of such associations may be pooled for cooperative sales. A number of feeding demonstrations with both fattening cattle and stocker cattle have been conducted. Personal visits are made to prospective feeders and specific instructions furnished for feeding the stock. The county agent assists by seeing that the instructions are carried out and by calling in the cattle specialists in case the results are not as satisfactory as they should be. Demonstrations are given with the assistance of the county agent and farmers of a community, showing how to plaster a silo, construct a hoisting device for getting silage out of pit silos quickly and economically, the proper arrangement of feed lots, sheds, feed bunks, etc. Advice on these points is also given by correspondence. All plans for silos, barns, and other farm buildings are furnished by the Office of Public Roads and Rural Engineering. The dissemination of results is accomplished through correspondence, circulars, bulletins, and the public press.

Cooperation.—States Relations Service, Office of Public Roads and Rural Engineering, State agricultural colleges, chambers of commerce, agents of the railroads, and live-stock men.

Location.—Washington, D. C., and the field.

Date begun.—1914.

Results.—(1) During 1916: The work of the previous year was continued, although not as much feeding was done in the winter of 1915–16 as in the preceding year, as it was a disastrous year for cattle feeders. A cooperative sale held by the Childress County Live-Stock Association of Texas was quite a success. One of the principal features of the work was the formation of the Buying and Selling Organization, which is really a committee composed of 15 stockmen and business men of the Panhandle, who get the buyers of grazing cattle from the States north of Texas to meet with the cattlemen at Amarillo, Tex., once a year for two or three days, during which time contracts are made for the cattle which are for sale.

(2) Prior to 1916: A feeding demonstration was conducted on the farm of Mr. J. M. Neely, near Amarillo, Tex., who constructed a feed shed and lot and a silo at his own expense. Two carloads of steers were divided into lots and the practice of grazing cattle on the range without feed compared with grazing on pasture supplemented by the feeding of cottonseed cake. These two lots were compared with others in the dry lot on silage made of kafir, milo, and milo heads. The cattle which ran on range was sold in January, as the weather was too severe for grazing long. The feeding of cottonseed cake to cattle on pasture was very profitable—more so than grazing without cake. It was clearly demonstrated that cattle would fatten rapidly on silage and milo maize heads and under average Panhandle conditions could be finished at a nice profit. During the spring and summer of 1914 a campaign was made for more silos, more silage, and better methods of putting up silage. In the fall of 1914 the agent aided in the construction of more than 100 silos, furnished plans for feed lots, and started several feeding demonstrations. He assisted the ranchmen in purchasing good sires and helped to find purchasers for surplus stock. During 1915 the work was continued and the agent supervised the feeding of about 700 head of cattle that were fattened for market. On quite a number of farms records were kept of the feeding operations, showing the cost of production, the daily gains, and the profit on the feeding experiments. These demonstrations showed quite clearly that the nonsaccharine sorghums could be used very advantageously in fattening cattle for the market.

Assignment.—W. F. Ward, S. H. Ray.

Proposed expenditures, 1916–17.—\$2,100.

(Beef-Cattle Extension Work in the Southwest: Superseded by project "Beef-Cattle Extension Work.")

(Animal Husbandry Extension Work in Tennessee: Discontinued as a separate project; included under "Live-Stock Demonstration Work in Areas Freed from Cattle Ticks.")

(Live-Stock Production on Irrigation Projects: Discontinued as a project of the Bureau of Animal Industry; work shown under the "Miscellaneous" section of this Program of Work.)

Total, Beef-Cattle Investigations, \$24,000, including \$1,000 statutory (research \$20,900; extension, \$3,100).

[Regulation.]

CERTIFICATION OF PEDIGREES.

Certification of Animals Imported for Breeding Purposes:

Object.—To determine the purity of breeds and identity of horses, dogs, and cats imported for breeding purposes under the provisions of paragraph 397 of the tariff act of October 3, 1913.

Procedure.—In accordance with the provisions of paragraph 397 of the tariff act of October 3, 1913, the customs officials require, for the entry free of duty of animals imported for breeding purposes, certificates issued by the Department of Agriculture stating that such animals are pure bred of a recognized breed and duly registered in the foreign book of record established for that breed. Under authority of this paragraph regulations of this department were issued and designated as B. A. I. Order 206. This order contains a list of the foreign societies recognized by the department and gives detailed directions for obtaining the certificates of pure breeding required by the customs officials. Upon the arrival of the animals at the port of entry they are examined by a Bureau of Animal Industry official, who reports to the Washington office the breed, sex, age, color, and markings. In case the data on the foreign certificates do not agree with the animal imported the bureau declines to issue the certificate of pure breeding. The pedigree given on the certificates is also checked with the published volumes, and those containing errors are returned for correction. In cases where the papers are found to be satisfactory this bureau issues the certificate of pure breeding and sends it to the collector of customs at the port of entry. The foreign certificate is stamped, showing that this bureau has found all papers satisfactory, and is returned to the importer. The work will be continued under the same general plan as outlined.

Cooperation.—Customs Division, Treasury Department.

Location.—Washington, D. C., and the field.

Date begun.—1911.

Results.—During the calendar year 1915, 274 horses, 583 dogs, and 5 cats were imported, for which certificates of pure breeding have been issued. Under this system of issuing certificates of pure breeding, American buyers, breeders, and record societies are guaranteed that the animals alleged to be imported are as represented. Publication has been made from time to time of lists giving the name, registry number, importer, port of entry, date of arrival, and the department number of horses and cattle brought into this country. As the tariff act of October 3, 1913, provides for the entry free of duty of all cattle, sheep, and swine, certificates of pure breeding are no longer issued by this bureau for those classes. During the calendar year 1914 certificates of pure breeding were issued for 1,195 horses, 597 dogs, and 12 cats. B. A. I. Orders 130, 136, 175, 186, and 206, with amendments, have been published in connection with this work of certification of pedigrees.

Assignment.—G. Arthur Bell, Charles C. Glenn.

Proposed expenditures, 1916-17.—\$3,000.

[Research.]

SHEEP AND GOAT INVESTIGATIONS.

Supervision:

Object.—The general supervision of the work in sheep and goat investigations, correspondence, and maintenance of record files pertaining to same.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—F. R. Marshall.

Proposed expenditures, 1916-17.—\$4,650.

Range Sheep Investigations:

Object.—The production of a range type of sheep from stock of Rambouillet blood; the adaptability of Corriedale sheep to western range conditions; the study of flock management; and breeding problems in range-sheep breeding.

Procedure.—The bureau's experimental flock comprises 400 grade Rambouillet ewes, 65 Corriedale ewes, and 280 long-wool Rambouillet crossbreds. The Rambouillets are descended from the stock procured in 1906-07 for the project entitled, "Breeding Range Sheep." Matings will be continued to improve the mutton value of the carcass and increase the length of wool while retaining the present quality of fiber. The Corriedale stock will be kept pure, with the view

Range Sheep Investigations—Continued.

of determining its adaptability to range conditions in various sections of the Western States. The crossbred flock will be continued until the experiment with the Corriedales has been properly tested. Sheep used in this work will be grazed in various lots to determine the effects of different systems of herding and the effects upon the sheep and upon the range of using fenced pastures, more accessible watering places, and various rates of stocking the pastures. Individual records will be kept of the ewes to furnish material for studying the factors controlling fecundity, growth, and wool production.

Location.—Laramie, Wyo., until such time as funds permit of the transfer to the United States sheep experiment station in Fremont County, Idaho.

Date begun.—1906.

Results.—The Rambouillet flock has now been in existence for nine years and gives promise of producing the type of sheep it was hoped to produce. The need of such a sheep as is aimed at in this project is more than ever apparent. The last crop of lambs produced in the flock show the closest approach yet secured to the type sought. One hundred and ninety-two ewes of the crop of 1914 were added to the flock.

The Corriedale flock was established by the importation of 75 head direct from New Zealand in 1915. The ewes passed through the winter on the range in good condition and produced a fair yield of lambs. It is yet too early to know the character of the wool they grow in this country or how their lambs develop.

In 1915 lambs of the F-2 generation from Lincoln and Rambouillet parentage were born. This stock furnishes a source of blood for a sheep suited to the needs for which the Corriedale is under test, in case there is doubt as to the adaptability of the latter. The records of the characters exhibited in this stock have furnished valuable data for studying the method of inheritance of wool characters.

Assignment.—F. R. Marshall, V. O. McWhorter.

Proposed expenditures, 1916-17.—\$8,440.

(Breeding Range Sheep: Discontinued as a separate project; included under "Range Sheep Investigations.")

(Study of Adaptability of Corriedale Sheep to American Range Conditions: Discontinued as a separate project; included under "Range Sheep Investigations.")

Farm Sheep Investigations:

Object.—To study the factors controlling yields of lambs and the rate of their growth; to determine for the main types of agricultural conditions in the farm States and for irrigated and dry-land farming areas the lines upon which sheep raising can be made most profitable; and to encourage New England farmers to return to sheep breeding and to furnish data as to returns from the practical management of farm flocks in New England.

Procedure.—A flock of 50 registered Southdown ewes is kept at the Morgan Horse Farm, Middlebury, Vt. Records kept permit a full study of the factors affecting reproduction, growth, and fleece characteristics. Experiments are carried on to test the feeding qualities of various classes of lambs produced in the flock and for obtaining data as to economical methods of using native pastures and forage crops in growing lambs and maintaining ewes. A similar flock is kept at the bureau's experiment farm at Beltsville, Md., for the further study of breeding and lamb production. The pasture and forage studies at this farm are planned on lines required by Maryland climatic and soil conditions, and these results will have application to a large area in the South Atlantic States. Thirty acres have been set aside for the exclusive use of experiments in testing methods and the possibilities of intensive sheep farming.

Cooperation.—Arrangements are being made to cooperate with experiment stations in Vermont, Maryland, and adjoining States in experiments in summer flock management and sheep raising demonstrations in selected counties. Where possible, similar cooperative work will be commenced in other farm States.

Location.—Washington, D. C., and the field.

Date begun.—1907.

Results.—(1) During 1916: It was found to be possible to keep lambs (in Vermont) thrifty by removing them from old pastures in June and having them graze only on forage crops grown on fresh ground. Twin lambs, as a lot, were found to be unable to reach the same weight at 12 months as lambs born as singles, though some individuals among the twins were equally as growthy as any of the singles.

Farm Sheep Investigations—Continued.

(2) Prior to 1916: Data as to receipts from farm flocks and costs of production have been procured. An improvement in the value of the fleece has been shown to be possible without deterioration of meat-producing qualities.

Assignment.—F. R. Marshall.

Proposed expenditures, 1916-17.—\$1,200.

(Breeding Sheep under New England Conditions: Discontinued as a separate project; included under "Farm Sheep Investigations.")

(Breeding an Early-Lambing Type of Mutton Sheep: Discontinued as a separate project; included under "Farm Sheep Investigations.")

(Production of Persian-Lamb Fur: Project discontinued. The work was not completed, but the stock was destroyed by fire, and the bureau is not now in a position to purchase new animals for the continuation of the work. It had been shown that the fur value of skins produced by mating Karakul rams with Barbados ewes is very low in the first cross but that later crosses show improvement. Quite probably animals of the fourth or fifth cross of Karakul rams upon suitable ewes would uniformly produce valuable skins, and such animals could be reared in many parts of the United States. A full summary of the work appeared in the Department Yearbook for 1915.)

Milch Goat Investigations:

Object.—To determine the most economical methods of breeding, feeding, and management of milking goats for infants' and invalids' use and in commercial cheese making.

Procedure.—A herd of 14 does of milking age is kept at the bureau's experiment farm, at Beltsville, Md. These are used in tests of milk-producing rations, and feeds for artificial rearing are tested with the young kids. The milk is produced under sanitary conditions and sent to the Dairy Division of this bureau for laboratory use. Another herd of milking goats is kept at the Sea View Hospital, New York, N. Y., to furnish milk for use in experiments upon the feeding of infants and invalids.

Cooperation.—Sea View Hospital, New York.

Location.—Beltsville, Md., and other points in the field.

Date begun.—1905.

Results.—(1) During 1916: Annual milk records of does of one-half and three-quarter Saanen and Toggenburg blood were obtained, as well as similar records for native does, the dams, and the grand-dams of the above. Tests of milk-producing rations were inaugurated and cooperative arrangements made for a full study of the properties and value of goat's milk.

(2) Prior to 1916: By the use of good sires of the milking breeds, in five years the herd of does has been changed from one of entirely native blood to one consisting chiefly of females having three-quarters of the blood of pure stock. The possibility of having some does freshen in the fall so as to furnish a continuous supply of milk has been demonstrated.

Assignment.—F. R. Marshall, V. O. McWhorter.

Proposed expenditures, 1916-17.—\$650.

(Milch Goat Breeding: Superseded by project "Milch Goat Investigations.")

Studies of Wool and Other Animal Fibers:

Object.—To determine for the various grades of wool the lowest shrinkage due to natural oil that is consistent with the maximum quantity and quality of wool; to learn how far the presence of skin folds and other body characters are associated with density of fleece and fineness of fiber; to study the relation of climate, soil, and feed, also age and heredity, as affecting the growth and quality of wool and other animal fibers used in commerce; to acquaint wool growers with the trade requirements and the various grades of wool; and to inform them regarding the best methods of preparing their clips for market.

Procedure.—Samples of wool, with full particulars regarding their source, will be obtained from sheep used in the projects "Range Sheep Investigations" and "Farm Sheep Investigations." The laboratory work will be done at the bureau's experiment farm, Beltsville, Md. Through bulletins and the circulation of an educational exhibit of wools, sheep raisers will be informed regarding breeding for wool and the handling and preparation of clips before marketing.

Cooperation.—Agricultural colleges in the main sheep-raising States.

Studies of Wool and Other Animal Fibers—Continued.

Location.—Washington, D. C., Beltsville, Md., Laramie, Wyo., and the field.

Date begun.—1913.

Results.—(1) During 1916: In the calendar year 1915 for the first time the plan of recording observations upon the most important characters of the fleece of each sheep used in other experiments was followed. A method of scouring to show shrinkage due to oil and to foreign matter has been partially worked out. During the first four months of 1916 an educational exhibit of wools was circulated in the States of Idaho, Montana, Utah, and Wyoming under a cooperative arrangement with the agricultural colleges of those States. In all, 50 towns were reached, and the car was visited by over 5,000 sheep raisers, besides residents of towns and delegations from public and high schools and three agricultural colleges. A motion-picture film entitled "From Wool to Cloth," which shows the various processes intervening between the shearing of the wool and the finished fabric, has been prepared for use in future educational work.

(2) Prior to 1916: Results of preliminary studies were reported in Department Bulletin 206, "The Wool Grower and the Wool Trade," of which 15,000 copies have been distributed.

Assignment.—F. R. Marshall, V. O. McWhorter.

Proposed expenditures, 1916-17.—\$5,000.

Total, Sheep and Goat Investigations, \$19,940, including \$900 statutory.

SWINE INVESTIGATIONS.**Supervision:**

Object.—The general supervision of the work in swine investigations, correspondence, and maintenance of record files pertaining to same, including the organization of pig clubs.

Cooperation.—States Relations Service and other bureaus of the department; agricultural colleges.

Location.—Washington, D. C., and the field.

Date begun.—1905.

Assignment.—George M. Rommel, W. F. Ward.

Proposed expenditures, 1916-17.—\$4,525 (research, \$3,800; extension, \$725).

[Research.]**Production of Pork:**

Object.—To study the effect of feed on the growth and quality of hogs and the keeping quality of pork; to study the effect of feed on the physiological condition of hogs; to study the toxic effect of cottonseed-meal feeding and the methods of farm curing of pork.

Procedure.—High-grade Berkshire pigs bred, raised, and fattened at the Beltsville farm are used. The conventional methods of conducting feeding experiments are followed to slaughtering time. The pigs are slaughtered on the farm and the weight of the offal taken. The feed is analyzed by using representative samples and the digestibility determined if data already available are not sufficiently accurate. The weight of the vital organs is taken and the bones tested for strength. A number of tests are made from time to time in cooperation with other bureaus to determine the value of new feeds for pork production, such as fish meal, potato meal, dry-land barley, etc. Experiments are under way to determine whether the toxicity of cottonseed meal can be lessened. The meat will be cured, smoked, and subjected to the necessary chemical analysis.

Cooperation.—Bureaus of Plant Industry and Chemistry.

Location.—Beltsville, Md.

Date begun.—1905.

Results.—(1) During 1916: Although tests of various kinds have been in progress during the past year, efforts have been largely devoted to preparation for future work.

(2) Prior to 1916: Feed rations have been studied and improvements made on certain standard ones. A number of experiments have been conducted to determine the effects of iron salts and other products to prevent cottonseed-meal poisoning.

Assignment.—George M. Rommel, Jas. D. Bebout, Frank G. Ashbrook.

Proposed expenditures, 1916-17.—\$7,275.

[Extension.]

Organization of Pig Clubs:

Object.—Through the organization of pig clubs, to stimulate an interest in swine production; to teach farm children improved methods of raising, fattening, and marketing hogs; to instill in them, while young, a love of animals which will result in their taking more interest in life upon the farm; and to furnish them at the same time with some work which will, in a practical way, give an insight into the business side of farm life.

Procedure.—The assistant in charge of the organization of the clubs works in connection with the county demonstration agents in the States which desire such cooperation. Wherever possible, he obtains the assistance of county superintendents of schools, teachers, and other persons who are in direct contact with young people. After the formation of the clubs, the assistant helps to instruct the members by sending out circular letters, bulletins, etc., which will aid them in their work. He assists in the purchase of pigs, arranges for exhibits, and helps to secure prizes to be offered at the county and State fairs. Complete records are kept of all phases of the work.

Cooperation.—States Relations Service, and the agricultural colleges in the States where the work is organized.

Location.—Washington, D. C., and the field.

Date begun.—1912.

Results.—The work is now being carried on in the following States: Alabama, Arkansas, California, Georgia, Indiana, Kentucky, Louisiana, Massachusetts, Nebraska, North Carolina, Oklahoma, Oregon, and Texas. Arkansas, California, Massachusetts, Oklahoma, Oregon, and Texas have been organized during the past fiscal year. A membership of over 11,000, representing 300 counties in the 13 States, won many prizes in the form of cash, scholarships, educational trips, equipment, etc. Prize contests were held in all of the States with very gratifying results. No accurate figures on the actual number of pigs raised are available, but the profits made by members, based on conservative estimates, aggregate approximately \$83,000. The membership will probably reach to 20,000 in 1916, and there will be a considerable increase in the number of counties represented. Pig-club supplies are being furnished to many other States. The demand for agents exceeds the funds available. Great interest in pure-bred breeding stock is manifested. Community breeding is established in some counties in several of the States. A "Daily Record Book" has been prepared and is being sent out to the members to enable them to keep complete records. The pig-club poster and emblem pin are very popular means of extending and keeping up the standard of club work. The poster is sent into various communities to show the value of improved methods in breeding and the emblem is awarded to members who send in satisfactory reports of their work.

Assignment.—W. F. Ward, J. D. McVean.

Proposed expenditures, 1916-17.—\$27,500.

Total, Swine Investigations, \$39,300, including \$1,800 statutory (research, \$11,075; extension, \$28,225).

[Research.]

HORSE AND MULE INVESTIGATIONS.**Supervision:**

Object.—The general supervision of the work in horse and mule investigations, correspondence, and maintenance of record files pertaining to these projects.

Location.—Washington, D. C.

Date begun.—1904.

Assignment.—G. Arthur Bell.

Proposed expenditures, 1916-17.—\$4,900.

Farm Horse and Mule Investigations:

Object.—To study problems in feeding, breeding, and management of horses and mules, with particular reference to their use as farm work animals.

Procedure.—The work stock at the bureau experiment farm at Beltsville, Md., will be used in making a study of working and feeding problems. Other work stock on the bureau farm and other farms may be used in these studies.

Cooperation.—Other divisions and bureaus of the department, farmers, and Iowa Experiment Station.

Farm Horse and Mule Investigations—Continued.*Location.*—Washington, D. C., and the field.*Date begun.*—1916.*Results.*—None to report as yet.*Assignment.*—G. Arthur Bell.*Proposed expenditures, 1916-17.*—\$3,400.

(**Study of Horse and Mule Raising and Feeding:** Discontinued as a separate project; included under "Farm Horse and Mule Investigations.")

Breeding American Carriage Horses:*Object.*—To produce a breed of horses from American material suitable for carriage and general purposes.*Procedure.*—This work was started by the purchase of six mares in December, 1904. A second purchase was made in February, 1905, of the Standardbred stallion Carmon and 12 mares, most of them bred in the corn-belt States, and Kentucky. Other mares were added in June, 1906, and 4 more in March, 1908. Only the best individuals are retained for this work, and those which are not needed are sold at public auction each year. About 25 mares and 6 stallions are in the stud. These mares were bred to the department stallions during the 1916 spring breeding season. The stallions were also available for public service, and a number of outside mares were bred to them.*Cooperation.*—Colorado Experiment Station.*Location.*—Fort Collins, Colo.*Date begun.*—1904.*Results.*—(1) During 1916: One stallion was sent to Carbondale, Colo., in the spring of 1915 and leased for two years. Two 3-year-old stallions were sent to other parts of Colorado for the 1916 spring breeding season.

(2) Prior to 1916: Very favorable progress has been made. One of the stallions produced in this work is Albion, foaled in 1906, a beautiful bay, weighing 1,380 pounds and standing 16½ hands high. This stallion, on account of his size, good disposition, and general high quality, is extremely popular among the farmers in that vicinity and is producing excellent colts. The mares in the stud will average better than 1,100 pounds and about 15½ hands high. The type is being reproduced and stallions are being sent out from the station. Three stallions bred at the station were sent out for the spring season in 1914. One was sent to Akron, Colo., one to Falcon, Colo., and one to Rock Springs, Wyo.

Assignment.—G. Arthur Bell, William P. Little.*Proposed expenditures, 1916-17.*—\$7,500.**Breeding Morgan Horses:***Object.*—To breed horses under New England conditions, establishing a stud and using horses of Morgan descent as the foundation; to preserve the Morgan type and blood lines. The market requirements and those of the New England farmers are kept in view. A larger horse than the old Morgan will be selected, namely, one standing about 15.2 hands and weighing from 1,050 to 1,100 pounds.*Procedure.*—Arrangements were made with the Vermont Experiment Station in the fall of 1905 to start this work on the station farm. The first purchase of stock was made in June, 1906, when seven mares and two fillies were bought from various persons in Vermont. In making the selections for the Morgan stud the effort was made to get the true Morgan type with an increase in size and quality over that possessed by the old Morgan. The stallion General Gates was purchased to head the stud in July, 1907, and later in the year two mares were added. Mr. Joseph Battell, of Middlebury, Vt., presented to the department a 400-acre farm in 1907 on which the work could be carried on. The stud was transferred to the farm in April of that year.*Cooperation.*—North Carolina Mechanical and Agricultural College.*Location.*—U. S. Morgan Horse Farm, Middlebury, Vt.*Date begun.*—1906.*Results.*—(1) During 1916: Corn silage has been fed to the brood mares during the past winter at the rate of 20 pounds per day. No bad effects from the feeding were noticed. Care was used to see that only silage of good quality was fed. Seven of the stallions from the farm were sent to other localities in Vermont and New Hampshire and used in the military-horse breeding work.

Breeding Morgan Horses—Continued.

(2) Prior to 1916: The work has progressed until it has reached the point where it is possible to send out stallions bred at the Morgan horse farm to stand in various localities in Vermont and New Hampshire. As the number of stallions increases they will be sent to other States. It is also possible to dispose each year of some females as registered mares. In March, 1915, one of the stallions was sent to Rutherfordton, N. C. Seventy-four mares were bred to this stallion in 1915. Stallions of other breeds have been tried at this place, but the results have not been satisfactory.

Assignment.—G. Arthur Bell, W. F. Hammond, V. G. Stambaugh.

Proposed expenditures, 1916-17.—\$15,900.

(Breeding Gray Draft Horses: Discontinued as a separate project; included under "Farm Horse and Mule Investigations.")

Breeding Horses on Indian Reservations:

Object.—To improve the quality of horses bred on Indian reservations by proper selection and the use of pure-bred stallions.

Procedure.—In 1913, four light (two Standardbred and two Saddlebred) and four draft (Percheron) stallions and four draft (Percheron) mares were purchased with money from the tribal funds of the Indians. It is hoped that this project will develop so that all stallions used on Indian reservations can be purchased direct from breeders by competent Government officers and the breeding work done on the reservations, supervised by the proper Government officials.

Cooperation.—Interior Department and War Department.

Location.—Cheyenne River Agency, S. Dak.

Date begun.—1913.

Results.—(1) During the calendar year 1915 there were 425 mares bred to the eight stallions used in this work.

(2) A horse barn has been built and the pastures fenced. During the 1914 season 518 mares were bred. The work is progressing very favorably and is popular among the Indians.

Assignment.—G. Arthur Bell, Archie Wells.

Proposed expenditures, 1916-17.—\$1,020.

Breeding Horses for Military Purposes:

Object.—To encourage the breeding of horses suitable for military purposes in localities where such horses are the most profitable type for farm use, and to encourage in general better horse-breeding methods among farmers.

Procedure.—The department places approved stallions in selected communities which are made available to owners of approved mares on the following terms: Service free in return for an option on the resulting foal during the year it is three years old at \$150. The owner of the foal may be released from his option at any time upon payment of the stipulated service fee. No fee is charged if the Government declines to purchase the foal.

Cooperation.—War Department.

Location.—Three horse-breeding districts have been organized as follows: First, Vermont and New Hampshire, headquarters at Middlebury, Vt.; second, Virginia and West Virginia, headquarters at Front Royal, Va.; third, Kentucky and Tennessee, headquarters at Lexington, Ky.

Date begun.—1912.

Results.—(1) On account of the lack of funds there were but 37 stallions available for the 1915 breeding season, and to these 2,158 mares were bred.

(2) Under the specific appropriation made by Congress for the Department of Agriculture for the fiscal year 1913, 34 stallions were purchased. These, with the five stallions from the Morgan horse farm and six which were donated, gave the department 45 stallions. During the 1913 season 42 stallions were stood, 1,579 mares being bred—an average of $37\frac{1}{2}$ per stallion. During the 1914 spring season 43 stallions were in service and 2,013 mares were bred—an average of 47 per stallion.

Assignment.—G. Arthur Bell, leader; W. F. Hammond, in charge of first district; H. H. Reese, second district; R. G. Lawton, third district.

Proposed expenditures, 1916-17.—\$26,800.

Total, Horse and Mule Investigations, \$59,520, including \$3,600 statutory.

POULTRY INVESTIGATIONS.

Supervision:

Object.—The general supervision of the work in poultry investigations, correspondence, and maintenance of record files connected with these projects.

Location.—Washington, D. C.

Date begun.—1908.

Assignment.—Harry M. Lamon.

Proposed expenditures, 1916-17.—\$7,320 (research, \$3,660; extension, \$3,660).

[Research.]

Farm Poultry Investigations:

Object.—To study the effect of rations, the inheritance of egg production, and other characters, the incubation of eggs, brooding, and the effect on health of fowls and on fertility of eggs of free range, small and large yards, and various styles of houses.

Procedure.—Pullets and hens are selected and fed rations for comparison. All females are trap-nested to determine their egg-laying ability, and pedigree records are kept of the offspring. Eggs from stock kept under various conditions are hatched in incubators and under natural conditions. Poultry will be raised by natural and artificial methods with various styles of equipment. In cooperation with the States Relations Service, experiments are being made with the respiration calorimeter to improve the methods of artificial incubation now in vogue. In natural incubation hens are set and a careful record kept of the temperature maintained by them. Eggs are placed in the incubator and a temperature record kept of them for comparison.

Cooperation.—Office of Home Economics, States Relations Service.

Location.—Washington, D. C., Beltsville, Md., and the field.

Date begun.—1910.

Results.—(1) During 1916: Three years' work has been completed at Beltsville, Md., and all of the pens of birds used in 1914 are being carried through another year, giving a four-year consecutive record on the oldest birds. Five new pens have been started, including three pens of mongrel chickens, making a total of 21 pens in all experiments. A bulletin on the feeding work which completed the three-year test is in course of preparation. Matings have been made for the study of inheritance of egg production. These matings include several hens whose yearly average was from 180 to 231. Young stock has been secured from these specimens, and their sons in turn are being bred to determine their prepotency. In the formation of a new breed individuals with yellow legs, four toes, white plumage, and good type have been produced, and among the females many lay a white-shelled egg. A few of the birds also have red ear lobes, but not all of these characters have been secured in the same individual to any extent as yet.

(2) Prior to 1916: Extensive detailed records were secured in 1910 of the cost of fattening poultry and the methods used in the fattening stations. These results were published in B. A. I. Bulletin 140, "Fattening Poultry." This work was continued in 1911 and 1912, and several experimental fattening tests were conducted under commercial conditions and the results published in Department Bulletin 21, "Commercial Fattening of Poultry." Feeding experiments have been conducted with various rations, including cottonseed meal with fish scrap.

Assignment.—Harry M. Lamon, Alfred R. Lee, Rob R. Slocum.

Proposed expenditures, 1916-17.—\$10,500.

(Poultry Feeding: Discontinued as a separate project; included under "Farm Poultry Investigations.")

(Poultry Breeding: Discontinued as a separate project; included under "Farm Poultry Investigations.")

(Incubation of Eggs: Discontinued as a separate project; included under "Farm Poultry Investigations.")

Turkey and Guinea Investigations:

Object.—To study the effect of different rations on the health of breeding stock, egg production, rate of growth of young stock, and fattening for market; to improve the quality of the different breeds; to develop and improve the meat qualities and meat-carrying capacity; to study methods of natural and artificial incubation and brooding; and to study the general management, such as free range and confinement, various styles of housing and shelter, methods of killing and dressing on the farm, and methods for the control and prevention of mortality in turkeys.

Procedure.—Methods of feeding and fattening will be studied on farms of turkey and guinea raisers in different sections of the country. Eggs will be set under turkey, guinea, and chicken hens and in incubators and will be brooded by natural and artificial methods. Different methods of killing and dressing will be tried out.

Location.—Washington, D. C., and the field.

Date begun.—1914.

Results.—(1) During 1916: In February, 1915, arrangements were made for a department representative to take up the study of turkey management on one of the large farms in southern Texas. By following the birds closely throughout the breeding, laying, hatching, brooding, growing, and marketing season, much valuable information was gained in a practical way. A bulletin on "Turkeys" has been prepared as a result of this investigational work and is in the hands of the printer.

(2) Prior to 1916: In September, 1914, a survey of the important turkey-raising sections of the country was started. Many turkey raisers in these sections were interviewed to secure information on their methods of caring for and raising the birds.

Assignment.—Harry M. Lamon, Andrew S. Weiant.

Proposed expenditures, 1916-17.—\$1,880.

(Management of Turkeys to Prevent Disease: Discontinued as a separate project; included under "Turkey and Guinea Investigations.")

Pigeon and Squab Investigations:

Object.—To study methods of rearing, feeding, breeding, housing, killing, dressing, and managing pigeons; to study the cost of production of squabs, the feeding of pigeons, and possible profits to be expected in this industry; to test different breeds of pigeons and the crosses of these breeds to determine their suitability and value for the production of squabs; and to study the possible improvement in prolificacy of squab breeders in breeding, selection, and feeding.

Procedure.—It is proposed, during the fiscal year 1916, to procure pigeons suitable for this work. A careful study will be made of the methods used in establishments where squab raising is conducted. The flock at the farm will be carefully studied to determine the economic possibilities of squab raising.

Location.—Washington, D. C., Beltsville, Md., and the field.

Date begun.—1915.

Results.—As a result of investigations made, Farmers' Bulletin 684, "Squab Raising," has been prepared to take the place of Farmers' Bulletin 177 on the same subject.

Assignment.—Harry M. Lamon, Alfred R. Lee.

Proposed expenditures, 1916-17.—\$340.

Ostrich Investigations:

Object.—To study the problems underlying the breeding, incubation, and feeding of ostriches in the United States; to cooperate with the Pathological Division of the bureau in studying the diseases and climatic conditions affecting them; to study the marketing of feathers; and to assist ostrich breeders in the preparation of their product for market.

Procedure.—This work was begun by making a study of grading and marketing feathers in New York, N. Y., in December, 1913. In January, 1914, several matings of different varieties of ostriches were made. The birds were fed different rations to determine what effect feeding has upon improvement in the quality of the feathers produced. The feeding experiments are being continued.

Cooperation.—Arizona Ostrich Breeders' Association, of Phoenix, Ariz.

Location.—Glendale, Ariz.

Date begun.—1913.

Ostrich Investigations—Continued.

Results.—In December, 1914, a cooperative arrangement was made with Messrs. Cook and Laird, members of the Arizona Ostrich Breeders' Association, to conduct experiments in ostrich investigations. During this month the department purchased 11 birds, as it was considered advisable to own the stock used in the experiments. From these birds some 50 specimens were hatched in the spring of 1915, and the majority of them were raised. In December, 1915, another opportunity occurred to secure what were considered several of the best pairs of ostriches owned in the Salt River Valley, and they were purchased and added to the Government flock.

Assignment.—Harry M. Lamon; Gardner L. Griffith.

Proposed expenditures, 1916-17.—\$2,500.

[Extension.]

Improvement of the Market Egg:

Object.—To study conditions surrounding the production of the market egg from the farm to the country store.

Procedure.—A general survey of the field of greatest poultry and egg production was made in the spring and summer of 1908. This was followed by the organization of the egg buyers in the State of Kansas to purchase eggs on the loss-off basis. In this campaign the assistance of the poultry club workers, farmers, and other producers and handlers of eggs was enlisted.

Cooperation.—Office of Markets and Rural Organization, Bureau of Chemistry, States Relations Service, State boards of health, State agricultural colleges, poultry packers, farmers, railroads, and country-store merchants.

Location.—Washington, D. C., and throughout the United States.

Date begun.—1908.

Results.—During 1915 and the preceding years since the egg placard was issued 50,000 of these posters have been sent out into the States in which poultry-club work is being carried on to continue the campaign for the improvement of the market egg. B. A. I. Bulletins 140, "Fattening of Poultry," 141, "The Improvement of the Farm Egg," and 160, "The Care of the Farm Egg," give the results of this work. An egg placard which shows the egg in various stages of incubation was prepared in 1912, and this has proved very valuable in the campaign for better market eggs. A miniature of the placard is to be found in Farmers' Bulletin 528, "Hints to Poultry Raisers." "Rooster Day" was inaugurated and has proved a prime feature in the work for infertile eggs.

Assignment.—Harry M. Lamon.

Proposed expenditures, 1916-17.—No allotment; work depends on obtaining support from other projects.

Organization of Boys' and Girls' Poultry Clubs:

Object.—Through the organization of poultry clubs, to stimulate an interest in poultry among farm boys and girls; to give a better knowledge of the value and importance of the poultry industry; to encourage better poultry management and the breeding of standard-bred poultry; to standardize poultry and poultry products; and to show how increased revenue may be obtained by marketing a first-class uniform product.

Procedure.—At the request of a State, through the proper extension department, the bureau details a poultry-club agent to serve in the State as a member of the extension department. His duties are to demonstrate to the county agent how poultry clubs are to be organized and to interest such agents in the principles of poultry husbandry. It is proposed to extend this work as appropriations permit, so that young people and others interested may be organized into poultry clubs in the States in which the department has demonstrations in progress. It is also proposed to demonstrate the practicability of poultry production in sections where it is not now carried on extensively and to improve the quality of the output of the farm.

Cooperation.—States Relations Service, State agricultural colleges and experiment stations, poultry and egg shipping associations, and breeders of standard-bred poultry.

Location.—Washington, D. C., and the field.

Date begun.—1912.

Results.—(1) During the past year the work was carried on in Virginia, South Carolina, North Carolina, Kentucky, Tennessee, Georgia, and Oklahoma. The work has continued to advance along progressive lines in all of the States organized. In each State a number of exhibits were held where prizes were

Organization of Boys' and Girls' Poultry Clubs—Continued.

offered for the best displays of eggs and fowls. The total awards during 1915 amounted to \$1,458.74, being an increase of \$679.66 over the 1914 awards. The summary for the calendar year of 1915 shows 6 States organized with 99 counties, 353 clubs, and 4,006 members. A new feature of the work has been the formation of community poultry-breeding associations among the grown people as well as with the children. A "Daily Record Book" has been prepared for the use of club members, which will assist them very materially in their work.

(2) Prior to 1916: The summary of the work in all States from the organization of Virginia in October, 1912, to 1914 shows 6 States organized with 41 counties and 3,188 members. The reports were not uniform in all cases, and no record can be given for the number of clubs organized during that period. Exhibits were held in some of the States and prizes offered for the best birds. The value of the awards offered during 1914 was \$779.

Assignment.—Harry M. Lamon, Jos. Wm. Kinghorne.

Proposed expenditures, 1916-17.—\$15,160.

Total, Poultry Investigations, \$37,700, including \$2,700 statutory (research, \$18,880; extension, \$18,820).

[Research.]

INVESTIGATIONS OF ANIMAL DISEASES.**Supervision:**

Object.—Supervision of all the investigations of animal diseases and the performance of duties common to this work.

Location.—Washington, D. C.

Date begun.—1884.

Assignment.—A. Eichhorn, B. H. Ransom, E. C. Schroeder.

Proposed expenditures, 1916-17.—\$13,520.

Rabies Investigations:

Object.—(1) The diagnosis of rabies in animals; (2) study of the disease to find the causative agent and to be able to grow this agent by laboratory methods; (3) determination of the significance of Negri bodies as to the causation of rabies.

Procedure.—(1) After procuring the head of an animal suspected of being affected with rabies smear preparations or sections of brain tissues are stained and examined to detect the presence of Negri bodies, which are considered diagnostic for rabies; the intracerebral injection of nervous tissue into healthy rabbits or guinea pigs to determine a case of rabies not diagnosable by the above method; the microscopic examination of the nervous tissues of rabbits dead from the inoculation with suspected rabies material from other animals. (2) The active causative agent being in dispute, importance of suspected agents, for instance, Negri bodies, bacilli, etc., is determined by the growing of these agents in artificial culture media, by isolating them in pure culture, growing them again, then through subsequent inoculations of susceptible animals with this growth in an endeavor to engender a typical case of rabies. (3) The study of the relation of Negri bodies to the disease is made by elimination of all material except these bodies, if this be possible, and the injection of these bodies alone into animals.

Location.—Washington, D. C.

Date begun.—1893.

Results.—During the fiscal year 1915 there were received for diagnosis 80 brains from suspected cases of rabies. Of these 36 dogs, 2 cows, 2 cats, and 1 hog were found to be affected.

Assignment.—J. S. Buckley, R. J. Formad.

Proposed expenditures, 1916-17.—\$2,600.

Dourine and Glanders Investigations:

Object.—To determine the presence or absence of dourine in suspected animals; to establish the extent of glanders infections among the horses and mules of the country, and to devise a method of vaccination that will protect animals from infection with glanders.

Procedure.—Samples of serum from suspected cases of dourine are subjected to the complement-fixation test for the establishment of the presence or absence of dourine.

Dourine and Glanders Investigations—Continued.

Horses are to be exposed to glanders infection, both in the stable and in the open air, and will be tested at intervals to determine the first evidence of infection. Various methods will be employed in the preparation of a potent and reliable vaccine.

Cooperation.—Office of Indian Affairs, Interior Department, and various officials in the States in which dourine eradication work is being executed.

Location.—Washington, D. C.

Date begun.—1913.

Results.—About 80,000 samples of serum from suspected cases of dourine are tested annually.

The impracticability of vaccination against glanders infection with dead glanders bacilli has been demonstrated and the reliability of the ophthalmic method of diagnosis proved.

Assignment.—A. Eichhorn, J. M. Buck, H. W. Schoening, R. A. Kelser.

Proposed expenditures, 1916-17.—\$12,400.

(Serum Diagnosis of Dourine: Discontinued as a separate project; included under "Dourine and Glanders Investigations.")

(Diagnosis and Investigation of Diseases of Animals Confined in the United States National Zoological Park: Discontinued as a separate project; included under "Miscellaneous Biological Experiments and Investigations.")

Forage Poisoning or Cerebrospinal Meningitis of Horses:

Object.—To determine the causative agent, devise measures for prevention, and detect and study the lesions of this disease.

Procedure.—The feeding materials or water that are suspected of being responsible for the disease are observed and studied. Laboratory bacteriological examination of animal fluids and tissues obtained from animals dead of the disease are made. Pathological examinations of the affected tissues are also conducted. By a study of the disease advice can be given to horse owners which may enable them to guard against the occurrence of the disease, as when the disease is recognizable it has passed beyond the present powers of help. By a study of the lesions of the disease it may be possible to determine whether hitherto unsuspected factors play any part in its causation. Inoculation experiments on horses of the fluids from a diseased horse or of bacterial cultures of diseased horses are made.

Location.—Washington, D. C.

Date begun.—1884.

Results.—Autopsies on affected animals have occasionally shown lesions of the central nervous system. Recent studies appear to indicate that the disease may be due to toxins generated by certain anaerobic microorganisms that possibly grow in the soil or in symbiosis with aerobic organisms upon plants.

Assignment.—John S. Buckley.

Proposed expenditures, 1916-17.—\$2,100.

Investigation of Animal Tuberculosis:

Object.—To gain further information about the causes responsible for the dissemination of tubercle bacilli and the propagation of tuberculosis among cattle, hogs, and other domestic animals; to determine what the results are from single exposure and from long-continued and uninterrupted exposure; to determine whether tubercle bacilli are commonly or at any time sufficiently numerous in the circulating blood of tuberculous animals to make them a factor requiring special consideration relative to the use of products from such animals as food; to prove whether it is possible to keep tuberculous and healthy cattle on small areas without the transmission of the disease; to find some method for the treatment of tuberculosis; to devise preventive means; to test the reliability of commercial tuberculin; to determine the frequency with which butter is infected with tubercle bacilli; to study John's disease and its cause, as well as other acid-fast bacilli; to develop a simple, safe, and economical method for disinfecting stables and pens which have been occupied by tuberculous animals; and to discover the most economical means for the eradication of bovine tuberculosis and John's disease and the gradual conversion of a tuberculous into a healthy herd of cattle.

Location.—Washington, D. C., and Bethesda, Md.

Date begun.—1884.

Investigation of Animal Tuberculosis—Continued.

Results.—It has been found that some species of animals are capable of harboring tubercle bacilli in their tissues for long periods of time without developing lesions of tuberculosis; that feces from tuberculous cattle are the most dangerous tuberculous material to which hogs are exposed under natural conditions, and that tuberculosis among brood sows does not seem to be a serious menace to their progeny if other exposure to infection is eliminated; that tubercle bacilli occur in the circulating blood of animals affected with advanced, more or less generalized tuberculosis, but not in the blood of tuberculous animals which have retained the appearance of health; that very little separation and relatively simple and inexpensive precautions are required to prevent the transmission of tuberculosis from affected to healthy herds; that all methods of treatment so far tested have proved unsatisfactory; that tuberculin prepared from avian tubercle bacilli may serve as a diagnostic agent in the detection of Johne's disease in cattle; that, though there is some variation in the strength of different brands of tuberculin, samples which fall below a reasonable standard of potency are very rare; that butter from time to time contains virulent tubercle bacilli and much more frequently acid-fast germs microscopically like tubercle bacilli which are incapable of causing tuberculosis in test animals; that thorough cleansing of stables infected with tuberculosis followed by a coat of whitewash is all that is required to make them safe for healthy animals; and that very few calves born in a tuberculous environment contract tuberculosis if left in such an environment until they are weaned.

Assignment.—E. C. Schroeder, A. Eichhorn.

Proposed expenditures, 1916-17.—\$8,150.

(**Demonstration of Tubercle Bacilli in the Tissues of Cattle That Have Reacted to Tuberculin:** Discontinued as a separate project; included under "Investigation of Animal Tuberculosis.")

(**Propagation of Acid-Fast Bacilli:** Discontinued as a separate project; included under "Investigation of Animal Tuberculosis.")

(**Producing Strains of Animals Immune to Tuberculosis:** Discontinued. It was found that means for producing strains of cattle immune to tuberculosis demanded the destruction of a large number of cattle and was therefore considered impracticable.)

(**Production of Preventive and Curative Bacterins for Takosis of Goats:** Completed. A bacterin for the prevention of takosis, which gives very promising results, has been produced.)

(**Investigation of Means of Utilizing City Garbage and Table Refuse:** Discontinued as a separate project; work now being done under Animal-Husbandry Investigations in connection with the project group "Swine Investigations.")

Investigation of Animal Abortion:

Object.—To gain further knowledge concerning the etiology, mode of transmission, and practicable means of eradicating the disease; to devise the most satisfactory method of disinfecting contaminated premises; and to determine the presence of the bacillus in suspected samples of market milk, as well as in hairless pigs, and goats and calves affected with goiter.

Procedure.—Material is obtained from aborting females of different species and from premature fetuses; cultures are isolated from each and these cultures studied comparatively. Various methods of diagnosis and of prevention are tested and efforts made to devise new procedures for diagnosis, prevention, and cure.

Cooperation.—New York State Veterinary College.

Location.—Washington, D. C., Bethesda, Md., and Ithaca, N. Y.

Date begun.—1908.

Results.—One herd of nearly 100 cattle, in which abortions formerly occurred frequently, after two years of treatment under the direction of the bureau has passed over several months without a single abortion. It has been demonstrated that the bacillus of infectious abortion occurs in the milk of infected cows; that infected cows remain permanent carriers of the infection long after seeming recovery; that animals that do not seem to find the *Bacillus abortus* specifically pathogenic may also serve as carriers; that a fairly large proportion of cows are naturally immune to abortion; that exposure to other natural means than copulation and ingestion is not a serious danger unless it occurs shortly before or after parturition; and that satisfactory medicinal treatment of the

Investigation of Animal Abortion—Continued.

disease remains to be discovered. Experiments in immunization and treatment with immune sera and other biological products gave encouraging results, but no definite conclusions have been reached.

Assignment.—E. C. Schroeder, A. Eichhorn, W. L. Williams.

Proposed expenditures, 1916-17.—\$50,000.

(Contagious Mammitis: Discontinued as a separate project; included under "Miscellaneous Biological Experiments and Investigations.")

(Investigation of the Birth of Immature and Hairless Pigs and Other Animals and of Goiter in Kids and Lambs: Discontinued as a separate project; included under "Investigation of Animal Abortion.")

Investigation of Swamp Fever:

Object.—To determine the nature, cause, and prevention of so-called swamp fever of horses, particularly to establish an accurate method of laboratory and clinical diagnosis. This involves a general study of the so-called filterable or ultravisible viruses and new methods of procedure in diagnostic technique.

Procedure.—Inoculation experiments and observations of field cases will be made. From these results material is to be obtained for laboratory tests in diagnosis, either by complement-fixation test or otherwise. The possibility of insect transmission will be determined by field observation and by exposure of susceptible horses to various insects.

Cooperation.—Minnesota Experiment Station and Minnesota Live-Stock Sanitary Board.

Location.—Washington, D. C., and St. Anthony Park, Minn.

Date begun.—1906.

Results.—It has been proved that the infection is not carried by stable flies or the common house fly.

Assignment.—C. F. Flocken.

Proposed expenditures, 1916-17.—\$2,600.

(Hemorrhagic Septicemia Investigations: Discontinued as a separate project; included under "Miscellaneous Biological Experiments and Investigations.")

(Investigation of Malta Fever: Project completed. A method of diagnosis by agglutination and the complement-fixation test has been established. Attempts at immunization with bacterial vaccines gave encouraging but not definite results. Data published in B. A. I. Circular 215, "Malta Fever, with Special Reference to Its Diagnosis and Control in Goats.")

Diagnosis of and Immunization against Anthrax:

Object.—To differentiate between anthrax and other diseases which bear resemblance to it; to perfect means of immunization against the disease by vaccination.

Procedure.—Blood and tissue specimens from animals manifesting symptoms of anthrax infection are examined microscopically and inoculated into laboratory animals. In positive cases the inoculation proves fatal within two or three days, the autopsy reveals lesions of anthrax, and anthrax bacilli may be demonstrated microscopically and culturally. Comparative tests are now being made with various methods of immunization against the disease.

Location.—Washington, D. C.

Date begun.—1888.

Results.—The presence or absence of anthrax infection in various herds throughout the country has been established through specimens submitted for examination. A simultaneous method of vaccination consisting of the injection of an immune serum and spore vaccine has proven satisfactory and possesses advantages over the Pasteur method. The use of the "serum alone" has been found of great value in the treatment of anthrax in man and animals.

Assignment.—A. Eichhorn, R. A. Kelser.

Proposed expenditures, 1916-17.—\$1,000.

(Investigation of Glanders: Discontinued as a separate project; included under "Dourine and Glanders Investigations.")

(Investigation of Dry Immune Serums: Discontinued. Immune serums have been concentrated by a special drying process in order to increase their keeping qualities. It was found that the dried sera when suspended in olive oil will retain their potency for a period of years.)

Investigations of Diseases of Fowls:

Object.—Diseases of fowls cause serious annual losses to the poultrymen of this country. The causes and characters of many of these infections are not fully understood, and the work of this project is to discover the causes and devise satisfactory measures of treatment.

Procedure.—Diseased birds, both living and dead, will be examined. Cultures will be made from them for the purpose of deriving diagnostic agents and curative serums or bacterins. Medicinal agents for the cure of these various maladies will also be tested.

Location.—Washington, D. C.

Date begun.—1907.

Results.—Experiments on immunization against fowl cholera gave satisfactory results against fairly large doses of virulent culture. A diagnostic agent for the detection of pullorum infection in mature fowls was developed. Bird pox in quail was investigated and found to be transmissible to fowl.

Assignment.—B. A. Gallagher, A. R. Ward.

Proposed expenditures, 1916-17.—\$1,400.

(Investigation of Avian Tuberculosis, Avian Diphtheria, Bird Pox, Fowl Cholera, White Diarrhea of Fowls, and Canker of Pigeons: Discontinued as a separate project; included under "Investigations of Diseases of Fowls.")

(Investigation of Infectious Enterohepatitis, or Blackhead, of Turkeys: Discontinued as a separate project; included under "Investigations of Diseases of Fowls.")

(Investigation of Johne's Disease, or Bacillary Enteritis, with Special Reference to Methods of Diagnosis: Discontinued as a separate project; included under "Investigation of Animal Tuberculosis.")

(Investigation of the Abderhalden Test for Pregnancy in Animals: Discontinued; found to be impracticable.)

Miscellaneous Biological Experiments and Investigations:

Object.—To establish methods for the control of hemorrhagic septicemia; to determine the specific nature of diseases affecting animals at the National Zoological Park for the purpose of controlling these diseases; to investigate market milk as it reaches the city after shipment from dairies in the country for the detection of pathological conditions; and to investigate numerous other diseases as required from time to time.

Procedure.—Bacterins are prepared from various cultures of hemorrhagic septicemia, and with these bacterins and living cultures attempts are made to immunize animals of different susceptible species and observe the durability of the immunity thus produced. Animals that die at the National Zoological Park are autopsied, and when necessary a histological study is made of the lesions which are present. Samples of milk are obtained at a city railway station, together with the address of the shipper. These samples are then tested for the purpose of ascertaining whether pathological properties are present in any of the shipments of milk.

Location.—Washington, D. C., Bethesda, Md., and Philadelphia, Pa.

Results.—An effective bacterin for the control of hemorrhagic septicemia has been prepared. Through the examination of animals from the National Zoological Park opportunities have been afforded for the study of diseases of great interest and importance. This work has also covered the experimental study of germicides, Texas fever, and feeding tests with raw, pasteurized, boiled, and sterilized milk. Chemical tests of market milk are made to determine the presence of enzymes, either harmful or beneficial.

Assignment.—A. Eichhorn, E. C. Schroeder.

Proposed expenditures, 1916-17.—\$12,850.

(Investigations of Trichinosis and Measles, and Other Zoological Investigations Relating to Meat Inspection: This project will be found under "Control of Meat and Meat Food Products," where it properly belongs.)

Index Catalogue and Collection of Parasites:

Object.—Maintenance of a comprehensive card index to the literature of animal parasites and a collection of specimens of parasites for study and reference.

Procedure.—Specimens of parasites are collected by bureau employees and by correspondents of the bureau in all parts of the world.

Cooperation.—Public Health Service, in maintenance of catalogue; National Museum, in maintenance of the collection of parasites.

Index Catalogue and Collection of Parasites—Continued.

Location.—Washington, D. C.

Date begun.—1890.

Results.—The literature of the entire world is rendered readily available by the index catalogue, which has been partially published in cooperation with the Public Health Service. The collection of parasites is one of the largest in existence and is of great value to the work of the Zoological Division.

Assignment.—B. H. Ransom, A. Hassall.

Proposed expenditures, 1916-17.—\$3,000.

Investigation of Roundworms of Sheep:

Object.—To obtain information relating to these parasites and to develop methods for their control and eradication.

Procedure.—The parasites are studied in the laboratory and in the field. A flock of sheep has been placed upon a farm near Vienna, Va., leased for the purpose, and experiments are being conducted to determine the effect of various methods of grazing and medicinal treatment upon infestation with stomach worms and other parasites.

Location.—Washington, D. C., and Vienna, Va.

Results.—The experiments with the first crop of lambs on the Vienna farm showed that none of several preventive methods depending upon the rotation of pastures without medicinal treatment was sufficient to protect the lambs from infestation, although in some cases the degree of infestation was slight. Lambs kept continuously in stables under ordinary farm conditions, although exposed to infested animals, acquired but few parasites. Valuable data concerning the longevity of parasitic roundworms of sheep have been obtained.

Probable date of completion.—Farm experiments at Vienna will probably be completed about 1921.

Assignment.—B. H. Ransom, Cooper Curtice.

Proposed expenditures, 1916-17.—\$11,000.

Investigations of Anthelmintics and the Treatment of Live Stock for Internal Parasites:

Object.—To determine the relative values of remedies used against internal parasites, and to work out methods for the practical treatment of live stock to destroy or remove internal parasites.

Procedure.—The remedies are administered to animals infested with parasites and the results observed. Laboratory studies are also made. Preliminary tests are supplemented by field tests on a larger scale in cases in which promising results are obtained from the preliminary work.

Cooperation.—Insecticide and Fungicide Board. The Zoological Division cooperates by testing in connection with this project remedies concerning which the board desires information.

Location.—Washington, D. C., and temporary locations in the field.

Date begun.—1915.

Results.—Successful use of oil of chenopodium as a remedy for intestinal worms in hogs; gasoline commonly recommended as a remedy for stomach worms in sheep has been found unsatisfactory; so-called worm preventives, consisting of mixtures of salt, charcoal, wood ashes, sulphate of iron, etc., found to be ineffective when fed to hogs; various remedies commonly used as anthelmintics have been found unsatisfactory.

Assignment.—M. C. Hall, W. D. Foster.

Proposed expenditures, 1916-17.—\$5,000.

(Investigation of Parasites of Hogs: Discontinued as a separate project; included under "Investigations of Anthelmintics and the Treatment of Live Stock for Internal Parasites.")

Investigation of Parasitic Protozoa, with Particular Reference to Blackhead in Turkeys:

Object.—To collect information relating to these parasites, which may be useful in their eradication and control.

Procedure.—Laboratory studies are made of various parasitic protozoa. Healthy turkeys are exposed to infection with blackhead, and the biology of the supposed causative organism of the disease and of other organisms associated with it studied.

Location.—Washington, D. C.

Date begun.—1908.

Investigation of Parasitic Protozoa, with Particular Reference to Blackhead in Turkeys—Continued.

Results.—Determination of further details in the life history of the Sarcosporidia; transmission of Sarcosporidia to healthy animals by food soiled with feces from infected animals, which is apparently the natural mode of infection among herbivorous animals.

Assignment.—H. Crawley.

Proposed expenditures, 1916-17.—\$2,500.

Investigations Relative to the Treatment and Control of Cattle Ticks, Mange Mites, and Other External Parasites:

Object.—To discover the most effective methods for the eradication and control of external parasites.

Procedure.—Various remedies and methods of treatment are tested to determine their efficacy in controlling and eradicating external parasites. So far as possible, bureau inspectors located in the district in which experiments are undertaken are utilized in carrying out the experiments under the direction of the leader.

Cooperation.—Bureau of Entomology, where life-history studies of the parasites (insects, ticks, etc.), are made; Insecticide and Fungicide Board (the Zoological Division cooperating by testing in connection with this project remedies concerning which the board desires information).

Location.—Headquarters at Kansas City, Kans.; experiments are conducted at various temporary locations in the field.

Date begun.—1908.

Results.—Farmers' Bulletin 713, "Sheep Scab," has been issued. A publication on the treatment and control of sheep ticks is in course of preparation. Investigations have been made relative to the treatment of lice affecting cattle, sheep, and hogs, ear ticks, ox-warbles, and mange of hogs, cattle, and other live stock.

Assignment.—Marion Imes.

Proposed expenditures, 1916-17.—\$9,000.

Miscellaneous Investigations of Animal Parasities, Their Control and Eradication:

Object.—To collect information relative to animal parasites and develop methods for their control and eradication. Under this head are grouped investigations upon which the amount of time spent is not sufficient to justify the establishment of separate projects.

Procedure.—Laboratory and field studies are made. New investigations are taken up from time to time and old investigations temporarily suspended are resumed as circumstances demand or opportunity offers.

Date begun.—1887.

Results.—Further data on the stomach worms of horses (*Habronema*) have been collected. Investigations of tapeworms of sheep and rabbits failed to show how these parasites are transmitted. During the year ending May 31, 1916, 63 imported sheep dogs were examined in quarantine for the presence of tapeworms transmissible to live stock, and 10 were found to be infested. Several outbreaks of parasitic diseases in various localities have been investigated. A number of miscellaneous publications on parasites, including a bulletin on the dog as a transmitter of disease (Department Bulletin 260), were issued during the year.

Assignment.—B. H. Ransom, M. C. Hall, W. D. Foster, B. Schwartz.

Proposed expenditures, 1916-17.—\$3,500.

General Maintenance of Bethesda Experiment Station:

Object.—This represents overhead charges incidental to the maintenance and upkeep of the buildings, fences, and equipment at the bureau experiment station at Bethesda, Md., together with the cost of planting and harvesting crops and other operations in connection with running the farm, which items can not be segregated and charged against specific investigational projects.

Location.—Bethesda, Md.

Date begun.—1897.

Assignment.—E. C. Schroeder.

Proposed expenditures, 1916-17.—\$20,000.

Breeding and Feeding Small Experiment Animals for Disease Research:

Object.—To breed and have available an abundant supply of small experiment animals of definite known history for the various investigations conducted by the several laboratories of the Bureau of Animal Industry.

Procedure.—Animals are bred under conditions to secure the highest productivity and greatest freedom from disease and weakness.

Location.—Bethesda, Md.

Date begun.—1889.

Results.—It has been proved repeatedly that the small experiment animals bred at the station cost less and are more valuable from every point of view than those which can be purchased.

Assignment.—E. C. Schroeder, George W. Brett.

Proposed expenditures, 1916-17.—\$6,540.

(Miscellaneous Animal-Disease Investigations: Discontinued as a separate project; included under "Miscellaneous Biological Experiments and Investigations.")

(Mounting Pathological Specimens for Exhibition Purposes: Completed. The method has been perfected and a sufficient number of specimens have been prepared.)

Investigations of Stock Poisoning by Plants:

Object.—To study and report on losses of stock from poisonous plants, and to develop methods of avoiding losses.

Procedure.—Feeding experiments are carried on with plants that are suspected of possessing poisonous properties and the effects of their ingestion carefully noted. Sheep are used in these tests.

Cooperation.—Forest Service and Bureau of Plant Industry.

Location.—Washington, D. C., and grazing districts of the West.

Date begun.—1904.

Results.—The presence of poisonous principles in various plants has been determined and methods of obviating losses from their ingestion shown.

Assignment.—C. D. Marsh, A. B. Clawson, W. N. Berg, W. W. Eggleston.

Proposed expenditures, 1916-17.—\$10,000.

Total, Investigations of Animal Diseases, \$177,160, including \$39,140 statutory.

[Research.]

CONSTRUCTION OF BUILDINGS AT BETHESDA AND BELTSVILLE.**Construction of Buildings at Bethesda and Beltsville:**

Object.—To provide proper barns, sheds, and other buildings for the animal-disease, animal-husbandry, and dairy research work.

Procedure.—It is proposed to construct at Bethesda, Md., in connection with the investigations of animal diseases, 4 concrete stock barns, size 30 by 25 feet each, to replace 2 very old, insanitary barns which have been in use 18 years, to cost \$2,000 each; 1 frame and steel barn, size 32 by 40 feet, to be used for the safe storage of hay, to cost \$600; an incinerator and galvanized-iron building to house it, size 22 by 20 feet; a retort, size 5 by 9 feet, 7 feet high, for the disposal of the carcasses of animals used in disease research work, to cost \$2,500.

Construction work at Beltsville for the Animal Husbandry Division will include the erection of a brick and hollow-tile sheep barn, size 50 by 30 feet, to be used to shelter the flock, for the storage of hay and grain, and to furnish space for wool investigations, to cost \$8,000. This building is to replace a barn which was burned last winter.

Building work at Beltsville for the Dairy Division will include the construction of 1 frame building for animals, size 24 by 26 feet, to be used for experimental work in milk secretion, to cost \$1,500; 1 frame shed, used to segregate diseased animals, size 40 by 20 feet, to cost \$500; 2 reinforced-concrete silos, size 42 by 16 feet, to supply additional storage for silage, necessary because of the increase of the herd, to cost \$500 each; 1 frame shed to connect the silo units, size 16 by 16 feet, to cost \$300; and 1 concrete reservoir, capacity 100,000 gallons of water, to furnish necessary fire protection, to cost \$1,200.

Location.—Bethesda and Beltsville, Md.

Date begun.—1897.

Assignment.—E. C. Schroeder, B. H. Rawl, George M. Rommel.

Proposed expenditures, 1916-17.—\$25,320, including \$1,720 statutory

INVESTIGATION, TREATMENT, AND ERADICATION OF HOG CHOLERA.

Supervision:

Object.—To direct and coordinate all research, extension, and control work relating to the cause and prevention of hog cholera.

Location.—Washington, D. C.

Date begun.—1913.

Assignment.—M. Dorset, O. B. Hess.

Proposed expenditures, 1916-17.—\$19,340 (research, \$14,340; regulation, \$4,000; extension, \$1,000).

(**County Hog-Cholera Investigation:** Discontinued as a separate project; included under "Hog-Cholera Control Looking to Eradication.")

(**Investigation of Methods of Producing Hog-Cholera Serum:** Discontinued as a separate project; included under "Investigation of Methods of Producing Immunity against Hog Cholera.")

(**Preparation of Hog-Cholera Serum:** Discontinued as a separate project; included under "Hog-Cholera Control Looking to Eradication.")

[Regulation.]**Hog-Cholera Control Looking to Eradication:**

Object.—The control of hog cholera looking to its eradication, and the production of serum used in the organization of the work.

Procedure.—The bureau will maintain in each State selected one or more competent veterinary inspectors to work in districts where arrangements satisfactory to the cooperating authorities can be made, with a view to the control and eradication of hog cholera. These inspectors will be furnished free serum and other necessary equipment for the forming of organizations and in qualifying veterinarians or others selected by the State authorities to combat hog cholera. Each State cooperating will provide office accommodations for bureau veterinarians, maintain one or more representatives to arrange for hog-cholera control work in the various districts, and deputize veterinarians or others selected to combat the disease.

Cooperation.—State officials having authority to enforce quarantine and sanitary measures for the control of contagious diseases of live stock.

Location.—Headquarters, Washington, D. C.; field work in various States yet to be selected; serum prepared at Ames, Iowa.

Date begun.—1913.

Results.—Further knowledge has been secured concerning the use of the serum preventive treatment under various conditions and a wider and more intelligent use of the serum throughout the country. The possibility of reducing hog-cholera losses and controlling the disease, by the use of the serum preventive treatment and the proper enforcement of quarantine and sanitary measures, has been demonstrated. In 1915 approximately 5,500,000 cubic centimeters of serum were produced.

Assignment.—O. B. Hess, M. Dorset.

Proposed expenditures, 1916-17.—\$128,540.

[Extension.]**Educational and Demonstrational Hog-Cholera Work:**

Object.—To prepare county agricultural agents and others to teach farmers how hog-cholera losses may be reduced by the application of the preventive serum treatment and proper quarantine and sanitary measures.

Procedure.—The Bureau of Animal Industry will maintain a competent veterinary inspector in each of a limited number of States, who will meet with county agricultural agents and others and describe to them the hog-cholera symptoms and post-mortem lesions; demonstrate the taking of temperatures and the application of the preventive serum treatment; and instruct them in ridding premises of infection and in quarantine and sanitary measures necessary to be taken to prevent the spread of the disease; having in mind that these agencies will convey this information to farmers.

Cooperation.—States Relations Service and the extension departments of State agricultural colleges.

Educational and Demonstrational Hog-Cholera Work—Continued.

Location.—Headquarters, Washington, D. C.; field work in States to be selected.

Date begun.—1913.

Results.—The necessity for more intensive work has been shown, and information concerning the nature of hog cholera and its prevention has been disseminated.

Assignment.—O. B. Hess.

Proposed expenditures, 1916-17.—\$20,000.

[Research.]**Investigation of Methods of Producing Immunity against Hog Cholera:**

Object.—To improve and cheapen present methods of immunizing hogs against hog cholera.

Procedure.—Investigations of various methods of producing serums and vaccines and a study of methods of standardizing these products will be made. This will involve laboratory studies, to be supplemented by field tests when required.

Location.—Washington, D. C., Ames, Iowa, and Bethesda, Md.

Date begun.—1908.

Assignment.—M. Dorset, R. R. Henley.

Proposed expenditures, 1916-17.—\$18,000.

Investigation of the Cause of Hog Cholera:

Object.—To determine and, if possible, cultivate artificially the specific micro-organism of hog cholera.

Procedure.—Laboratory studies will be made of sick hogs and of the infectious body fluids of such hogs to determine the character of the infectious agent which produces the disease.

Location.—Washington, D. C., Ames, Iowa, and Bethesda, Md.

Date begun.—1903.

Assignment.—M. Dorset, F. W. Tilley.

Proposed expenditures, 1916-17.—\$8,000.

Investigation of the Mode of Dissemination of Hog Cholera:

Object.—To secure definite information concerning the life of hog-cholera virus on infected premises and the ways in which virus is carried from farm to farm as well as from animal to animal.

Procedure.—Studies will be made of infected premises and of various supposed carriers of hog cholera, including birds and insects. Attempts will be made to secure definite information concerning the life of hog-cholera virus in the soil. Other related questions will be investigated.

Location.—Washington, D. C., and Ames, Iowa.

Assignment.—M. Dorset, C. N. McBryde, W. B. Niles.

Proposed expenditures, 1916-17.—\$5,000.

Total, Investigation, Treatment, and Eradication of Hog Cholera, \$198,880, including \$13,880 statutory (regulation, \$132,540; research, \$45,340; extension, \$21,000).

[Regulation.]**CONTROL OF THE MANUFACTURE, IMPORTATION, AND SHIPMENT OF VIRUSES, SERUMS, ETC.****Supervision:**

Object.—Supervision of all the work of enforcing the law governing the interstate shipment and the importation of viruses, serums, toxins, and analogous products intended for use in the treatment of domestic animals, including the direction of some 71 employees at the various localities in the United States where such products are prepared, and the performance of duties common to the whole work.

Location.—Washington, D. C.

Date begun.—1913.

Assignment.—M. Dorset, A. Eichhorn, H. J. Shore.

Proposed expenditures, 1916-17.—\$9,000.

Special Supervisory Inspection:

Object.—To see that the law, regulations, and instructions governing the preparation, sale, barter, exchange, shipment, and importation of viruses, serums, toxins, and analogous products intended for use in the treatment of domestic animals are properly observed.

Procedure.—Personal investigations are made of licensed establishments and of the conduct and inspection of operations at licensed establishments which prepare hog-cholera virus and anti-hog-cholera serum; collection of suspected samples and investigation of reported violations of the law.

Location.—Washington, D. C., Kansas City, Kans.; official stations of supervising inspectors and traveling inspectors.

Date begun.—1913.

Results.—More uniform conditions at licensed establishments; increased efficiency.

Assignment.—H. J. Shore, D. I. Skidmore.

Proposed expenditures, 1916-17.—\$6,000.

Inspection of Establishments:

Object.—To determine whether or not licenses should be issued to establishments engaged in the preparation and disposal of serums, viruses, vaccines, toxins, etc., and to determine whether the products of licensed establishments are pure and potent.

Procedure.—Inspection and supervision of the operations of licensed establishments engaged in the preparation of viruses, serums, toxins, and analogous products. This work for the most part consists of inspection of methods of preparation and inspection of tests for purity and potency of anti-hog-cholera serum.

Cooperation.—Collectors of customs, Treasury Department.

Location.—Washington, D. C., and various cities where licensed plants are located.

Date begun.—1913.

Results.—During the fiscal year 1915 there were 142 licenses issued, 2 refused, 2 canceled, and 1 revoked; 2 permits were issued; 6 convictions for violations of the law and 6 violations under investigation; also 3,769,962 cubic centimeters of worthless or contaminated serum were withheld from market.

Assignment.—M. Dorset, A. Eichhorn, H. J. Shore.

Proposed expenditures, 1916-17.—\$171,200.

Total, Control of the Manufacture, Importation, and Shipment of Viruses, Serums, etc., \$186,200, including \$11,200 statutory.

(Insecticide and Fungicide Investigations: This group of projects has been discontinued, the work being covered under "Enforcement of the Insecticide Act.")

[Regulation.]

ERADICATION OF DOURINE.**Eradication of Dourine:**

Object.—Eradication of this disease, in order to prevent its spread and thereby encourage the breeding of horses in districts where dourine is prevalent.

Procedure.—Inspection of all horses in areas where the disease is known to exist and removal of stallions in such areas from the open range; the securing of blood serum from each animal, forwarding serum to the bureau laboratory at Washington for examination by the complement-fixation method; slaughter of all mares reacting to the test and slaughter or castration of all reacting stallions.

Cooperation.—Office of Indian Affairs, Interior Department, and various officials in the States in which the work is conducted.

Location.—Western Nebraska, western North Dakota, western South Dakota, eastern Montana, eastern Wyoming, and the Navajo Indian Reservation in Arizona and New Mexico.

Date begun.—1912.

Results.—During the fiscal year 1915 inspections were made and samples of blood serum from horses tested to the number of 52,896, of which 1,515, or 2.7 per cent, gave positive reactions.

Probable date of completion.—1918.

Assignment.—R. W. Hickman.

Proposed expenditures, 1916-17.—\$75,000.

CONTROL OF MEAT AND MEAT FOOD PRODUCTS.**Supervision:**

Object.—Supervision of all the work of meat inspection, including the direction of some 2,500 employees at all the slaughtering centers of the United States, and the performance of duties common to the whole work.

Location.—Washington, D. C.

Date begun.—1891.

Assignment.—R. P. Steddom, M. Dorset, A. Eichhorn, B. H. Ransom.

Proposed expenditures, 1916-17.—\$74,180 (regulation). This figure includes \$10,000, shown under the Office of the Secretary, project "Rent in the District of Columbia."

[Regulation.]

Purchase, Preparation, and Distribution of Brands and Branding Ink:

Object.—To provide suitable fluid and branding appliances for marking carcasses, parts of carcasses, and meat and meat food products inspected under the meat-inspection act.

Procedure.—Branding ink is prepared in the laboratories at Washington, D. C., and shipped to the inspectors in charge of meat inspection. Careful tests are made to determine what brands and equipment are best for applying the ink.

Location.—Washington, D. C.

Date begun.—1906.

Results.—During the past fiscal year 2,475 gallons of ink were manufactured and 1,675 brass brands procured, bearing the inspection legend and official establishment number, which were supplied to the inspectors for marking meats. The use of the ink and brands has resulted in a saving of many thousands of dollars annually as compared with the cost of marking the meat prior to the inauguration of this system.

Assignment.—T. M. Price, W. H. Smith.

Proposed expenditures, 1916-17.—\$9,500.

(Preparation and Distribution of Branding Ink: Discontinued as a separate project; included under "Purchase, Preparation, and Distribution of Brands and Branding Ink.")

Special Supervisory Inspection:

Object.—To see that the law, regulations, and instructions governing meat inspection are properly observed.

Procedure.—Personal investigations are made of official establishments and of the conduct and inspection of operations.

Location.—Washington, D. C., Chicago, Ill., Nashville, Tenn., Philadelphia, Pa., Milwaukee, Wis., Boston, Mass., and Portland, Oreg.; official stations of the traveling veterinary inspectors, bureau architect, and sanitary engineer.

Date begun.—1906.

Results.—More uniform inspection, increased efficiency, and better sanitary conditions have been secured. These favorable results have obtained ever since this system of inspection was inaugurated.

Assignment.—R. P. Steddom, George Ditewig, A. J. Pistor.

Proposed expenditures, 1916-17.—\$43,500.

(Meat-Inspection Brands: Discontinued as a separate project; included under "Purchase, Preparation, and Distribution of Brands and Branding Ink.")

Laboratory Inspection:

Object.—To ascertain whether meat and meat food products prepared in official establishments or under exemption or those shipped interstate by farmers, as well as imported meats and meat food products, are properly labeled, sound, healthful, wholesome, and otherwise fit for human food, and to determine whether any prohibited substance has been used in their preparation or in and about the establishment; also to determine whether the water and ice used in the preparation of meat and meat food products are potable.

Procedure.—Samples of all meat, meat food products, and ingredients used in their preparation are collected and submitted to chemical, physical, microscopical, and bacteriological examinations. Chemical and bacteriological examinations are made of samples of all waters and ice used in the preparation of meat and its products. Examinations are also made of various preparations used in and about establishments.

Laboratory Inspection—Continued.

Cooperation.—Bureau of Chemistry; Bureau of Internal Revenue, Treasury Department.

Location.—Washington, D. C., New York, N. Y., Chicago and East St. Louis, Ill., Omaha, Nebr., Kansas City, Mo., and San Francisco, Cal.

Date begun.—1906.

Results.—The total number of samples examined during the fiscal year 1916 was approximately 70,000; 275 samples of water examined, and 35 water supplies condemned.

Assignment.—T. M. Price.

Proposed expenditures, 1916-17.—\$90,000.

(**Special Laboratory Inspection and Examination:** Discontinued as a separate project; included under "Laboratory Inspection.")

Ante-Mortem Inspection of Animals for Slaughter:

Object.—To discover animals which show symptoms of or are suspected of being affected with any disease or condition which would probably cause their condemnation in whole or in part when slaughtered, and to hold such animals apart and slaughter them separately from other animals so as to insure careful post-mortem inspection as provided in the regulations governing Federal meat inspection.

Procedure.—An ante-mortem inspection and examination is made of all cattle, sheep, swine, and goats before they are slaughtered in an official establishment. This consists of visual and digital examinations and, when necessary, recording the temperatures of these animals.

Cooperation.—This work is conducted in cooperation with the State and local authorities at a few points.

Location.—Washington, D. C., and 142 cities, more or less, throughout the United States at which leaders are stationed. (See list of stations, which follows.)

Date begun.—1906.

Results.—During the fiscal year 1915 there were inspected 58,231,862 animals, of which 202,154 were marked as "suspects" and 9,352 were condemned. Data in the 1915 annual report of the Bureau of Animal Industry. Prior to the year 1916, 494,000,000 animals were inspected and over 900,000 tagged as "suspects."

Assignment.—R. P. Steddom, George Ditewig, A. J. Pistor. (See also list of stations, which follows.)

Proposed expenditures, 1916-17.—\$200,000.

Post-Mortem Inspection of Animals:

Object.—To make a careful examination and inspection of the carcasses and parts of all cattle, sheep, swine, and goats slaughtered at official establishments to determine the presence in any such carcasses or parts of any lesions of disease or other condition which might render the meat or any organ unfit for food purposes; and to condemn and to cause to be destroyed for food purposes all carcasses or parts thereof of animals found on final inspection to be unsound, unhealthful, unwholesome, or otherwise unfit for human food.

Procedure.—Visual and digital examinations are made, and, where necessary, the lymphatic glands, organs, or parts are incised.

Cooperation.—This work is conducted in cooperation with the State and local authorities at a few places.

Location.—Washington, D. C., and 142 cities, more or less, throughout the United States at which leaders are stationed. (See list of stations, which follows.)

Date begun.—1906.

Results.—During the fiscal year 1915 there were inspected 58,022,884 animals, of which 57,608,008 were passed as suitable for food purposes, 124,270 for sterilization, and 290,606 condemned and destroyed as unfit for food purposes. Prior to the year 1916, 493,000,000 carcasses were inspected, of which 1,600,000 were condemned, together with 6,000,000 parts of carcasses.

Assignment.—R. P. Steddom, George Ditewig, A. J. Pistor. (See also list of stations, which follows.)

Proposed expenditures, 1916-17.—\$1,260,000.

Supervision of the Preparation and Distribution of Meats:

Object.—To inspect meat and meat food products prepared within and brought into official establishments and departments thereof to see that no unfit meat or product is used in the various processes of preparation, packing, salting, smoking, canning, etc., to insure proper labeling, and to see that establishments are maintained in a sanitary condition, that the workers are clean as to person and raiment, and that deleterious preservatives or ingredients are not used; and otherwise to enforce compliance with the meat-inspection law and regulations.

Supervision of the Preparation and Distribution of Meats—Continued.

Procedure.—All meats, before entering into the preparation of the various products, are examined and inspected physically to see that they are sound, healthful, wholesome, and fit for human food, and that they have been "United States inspected and passed." Each stage in the preparation of the various products is supervised to insure that it is performed under approved sanitary conditions, the products in course of preparation being frequently reinspected in order that no product may be allowed to enter into human consumption which has become unsound, unhealthful, unwholesome, or otherwise unfit for food purposes, or which contains any deleterious dye, chemical, preservative, or other ingredient which would render such product unfit for human food.

Location.—Washington, D. C., and 226 cities, more or less, in which leaders are stationed. (See list of stations, which follows.)

Date begun.—1906.

Results.—During the fiscal year 1915 the work represented inspections equivalent to 7,533,070,002 pounds of meat and products thereof, of which 18,780,122 pounds were condemned as unfit for human food. Prior to the year 1916 the condemnations of meat and products thereof amounted to 197,000,000 pounds.

Assignment.—R. P. Steddom, George Ditewig, A. J. Pistor. (See also list of stations, which follows.)

Proposed expenditures, 1916-17.—\$1,390,000.

Inspection of Meats for the United States Navy:

Object.—To insure that the meat and meat food products furnished the Navy have been inspected and passed and are so marked, that they are sound and fit for food purposes at the time of delivery, and that such articles conform to the specifications of the Navy.

Procedure.—The preparation of meat and meat food products for the Navy in accordance with special specifications is supervised to insure that such specifications are met. This supervision includes methods of curing, processing, and handling the articles. Reinspections are made when the articles are delivered to ships, navy yards, and other naval institutions, to see that they conform to the specifications and are sound and in every way fit for food.

Cooperation.—Bureau of Supplies and Accounts of the Navy Department.

Location.—Washington, D. C., Baltimore, Md., Boston, Mass., New York and Brooklyn, N. Y., Augusta, Ga., Natchez, Miss., New Orleans, La., Norfolk, Va., Sioux City, Iowa, Philadelphia, Pa., Portland, Oreg., Newport and Providence, R. I., Los Angeles, San Diego, and San Francisco, Cal., and Seattle, Wash.

Date begun.—1907.

Results.—During the fiscal year 1915 meat and meat food products inspected for the United States Navy amounted to 12,808,056 pounds, of which 455,479 pounds were rejected. This inspection for the Navy for several years has been the means of securing better meat for that department.

Assignment.—R. P. Steddom, George Ditewig, A. J. Pistor.

Proposed expenditures, 1916-17.—\$9,000 (to be reimbursed by the Navy Department).

Inspection at Public Markets:

Object.—To provide for the interstate transportation or export from public markets of portions of inspected and passed meats and products thereof which, when cut or otherwise removed from a marked carcass, part, or container, do not show the inspection legend.

Procedure.—The unmarked portions of meats cut from a properly marked carcass or meat food products removed from a properly marked container in the presence of a bureau inspector are examined by him and if found to be sound, healthful, wholesome, and fit for human food, are marked with the inspection legend.

Location.—Washington, D. C., and 44 cities, more or less, in which leaders are stationed. (See list of stations, which follows.)

Date begun.—1908.

Results.—This inspection has permitted shippers to forward in interstate and foreign commerce meats which otherwise would have been prohibited shipment from the State.

Assignment.—R. P. Steddom, George Ditewig, A. J. Pistor.

Proposed expenditures, 1916-17.—\$15,000.

Supervision of Operations Conducted under Certificates of Exemption:

Object.—To ascertain whether or not shippers are in reality retail butchers, retail dealers, or farmers; also to see that the premises in which animals are slaughtered or where meat and meat food products are prepared by or for persons who make interstate shipments under exemption from inspection are maintained in a sanitary condition, and that the articles so shipped are sound, healthful, wholesome, and fit for human food.

Procedure.—The inspectors visit and examine the premises and ascertain the character of the business of the shipper. If the provisions of the regulations are met, numbered certificates of exemption are issued. These certificates are required in connection with the interstate transportation of meat and meat food products. In case the holder of a certificate of exemption fails to conform to the regulations, his certificate is revoked.

Cooperation.—State officials having jurisdiction over meat and its products within the State.

Location.—Washington, D. C., and 234 cities, more or less, in which leaders are stationed. (See list of stations, which follows.)

Date begun.—1906.

Results.—At the close of the fiscal year 1915 there were 2,130 exemption certificates outstanding. During that year 84,769 shipments were made by retail butchers under authorization of the certificate of exemption. Similar favorable conditions for shipments by retailers have obtained ever since this supervision has been effective.

Assignment.—R. P. Steddom, W. H. Smith.

Proposed expenditures, 1916-17.—\$12,000.

Examination of Imported Meats and Meat Food Products:

Objects.—To prevent the importation of meat and meat food products of cattle, sheep, swine, and goats which are not properly certified, or which are falsely labeled, or which are unsound, unhealthful, unwholesome, or otherwise unfit for human food, or which contain any prohibited dye, chemical, preservative, or other harmful ingredients.

Procedure.—The foreign certificates of all shipments of meat and products offered for importation are examined to see that they conform to the department regulations. The meat and meat food products are carefully inspected and examined. Samples of consignments are given chemical examination. Only such products are admitted as are sound, healthful, wholesome, and fit for human food, are free from prohibited dye, chemicals, preservatives, and other harmful ingredients, and are properly labeled.

Cooperation.—Treasury Department and in certain instances the Bureau of Chemistry.

Location.—Washington, D. C., and 61 cities, more or less, in which inspection of imported meats and meat food products embraced under this project is made.

Date begun.—1913.

Results.—During the past year 247,114,183 pounds of imported meat were examined, of which 2,020,291 pounds were condemned and 70,454 pounds refused entry.

Assignment.—R. P. Steddom, W. H. Smith.

Proposed expenditures, 1916-17.—\$50,000.

(Field Laboratory Inspection and Examination: Discontinued as a separate project; included under "Laboratory Inspection.")

Field Overhead, and Miscellaneous Meat Inspection:

Object.—To cover the overhead charges, such as details of inspectors in charge, supervisors, clerks, etc., at the meat inspection stations throughout the United States, also minor activities not included under other projects of this group.

Procedure.—Various minor transactions incidental to the maintenance of meat inspection at 228 cities, more or less, in the field, the transfer of employees between stations, and other miscellaneous items which are common to the control of meats and products thereof at such cities.

Location.—At 228 cities and towns, more or less, throughout the United States.

Date begun.—1891.

Assignment.—See list of stations, which follows.

Proposed expenditures, 1916-17.—\$313,580.

[Research.]

Bacteriological Investigations of Meat and Meat Food Products:

Object.—To aid inspectors to determine the proper disposition of questionable meat and to enable packers to prevent spoilage, through bacterial investigations.

Location.—Washington, D. C.

Date begun.—1907.

Results.—The cause of ham souring has been worked out and suggestions offered for its prevention. The reliability of the hot-room test as a means of detecting defective cans has been established and regulations governing the reprocessing of such cans adopted. The canning of sausage in oil has been investigated, and as a result regulations governing the preparation of this product have been adopted. The bacteria in the carcasses of hog-cholera hogs have been studied, with the result that no organisms of *Bacillus enteritidis*, or meat-poisoning type, were encountered. A bacteriological investigation of beef-ham pickles has been made, and as a result the use of these pickles in the manufacture of meat extracts has been prohibited. The process of dehairing and washing hog carcasses has been investigated, and it has been found that under certain conditions hair and dirty wash water entered the wound in the neck and penetrated through the blood vessels as far as the liver. Instructions were issued with a view to preventing this trouble. Reports have been made on the routine examination of meat samples, including (1) samples suspected of having caused meat poisoning, (2) samples which have undergone putrefactive changes such as would render them unfit for food, and (3) samples showing various discolorations due to molds and other causes.

Assignment.—C. N. McBryde.

Proposed expenditures, 1916-17.—\$3,500.

Investigation of Changes in Meats during Preservation:

Object.—To study the changes which take place in meats during preservation by various methods, with particular reference to the cause of such changes and their effect upon the wholesomeness and nutritive value of the product.

Location.—Washington, D. C., and other cities where meat-packing establishments under Government inspection are located.

Date begun.—1913.

Results.—The causes and nature of the changes which take place in fresh beef during cold storage have been determined. Reports of the results of these studies have been submitted for publication under the following titles: "Changes Taking Place in Fresh Beef During Cold Storage at Temperatures Above Freezing," "Effect of Autolysis upon Muscle Creation," and "The Formation of Hematoporphyrin in Ox Muscle During Autolysis."

Assignment.—Ralph Hoagland, C. N. McBryde.

Proposed expenditures, 1916-17.—\$5,000.

(Investigation of Changes in Fresh Meat in Cold Storage: Superseded by project "Investigation of Changes in Meats during Preservation.")

Investigation of Canned Meats:

Object.—To develop, through chemical and bacteriological studies, information concerning the effect which prolonged storage has upon canned meats.

Location.—Washington, D. C., and certain cities where meat-inspection establishments are operating under supervision of the Federal Government.

Date begun.—1909.

Results.—Work incomplete; will continue for several years. Analyses are made once each year.

Assignment.—T. M. Price, C. N. McBryde.

Proposed expenditures, 1916-17.—\$4,000.

Investigation of Pathological Conditions Noted during Meat Inspection:

Object.—The investigation of any abnormal, unusual, or hitherto unnoted condition of interest, directly or indirectly, from the meat inspection viewpoint, which may be encountered during routine Federal meat inspection. Special emphasis is laid upon infectious conditions and those characterized by malignancy.

Investigation of Pathological Conditions Noted during Meat Inspection—Continued.

Procedure.—Bacteriological examination in the fresh state by means of unstained and stained smears, as well as culture sowings from the tissue under investigation, for the purpose of demonstrating or eliminating material of an infectious nature and likewise differentiating and recovering, where possible, the causative agent. Preparation of the suspected material by freezing or other hardening methods, so that the tissue involved may be sectioned and studied microscopically in regard to their histologic structure for the recognition of any deviations from the normal that may be present.

Location.—Washington, D. C., Chicago, Ill., and South Omaha, Nebr.

Date begun.—1906.

Results.—Pathological conditions of a puzzling character are frequently discovered during meat inspection. The study of these is of great assistance in the disposition of the carcasses affected.

Assignment.—H. J. Washburn, L. E. Day, G. B. Morse.

Proposed expenditures, 1916-17.—\$10,000.

Investigation of Trichinosis and Measles, and Other Zoological Investigations Relating to Meat Inspection:

Object.—To improve methods of meat inspection in so far as parasitic diseases of food animals are concerned.

Procedure.—Parasitic conditions found in the course of meat inspection are investigated. Problems relating to specific parasites are studied with reference to their bearing on meat inspection. These studies are continued from year to year, different problems being taken up in turn. Special investigations of trichinosis will be continued at Chicago and Washington.

Location.—Washington, D. C., and various meat-inspection stations.

Date begun.—1884.

Results.—Information has been obtained relative to methods of examination for parasites, their prevalence in meat, and the effects of refrigeration, cooking, and curing upon the vitality of trichinae, which has been used as a basis for meat-inspection regulations. Certain curing processes have been found to be uncertain in their effects; others have been uniformly successful in destroying the vitality of trichinae.

Assignment.—B. H. Ransom, W. N. Neil, H. B. Raffensperger, B. Schwartz.

Proposed expenditures, 1916-17.—\$3,500.

Investigations upon the Control of the House Fly and Other Insects in Establishments Operating under Federal Meat Inspection:

Object.—To devise plans for the control and eradication of the house fly and other insects in establishments operating under Federal meat inspection.

Procedure.—Study of conditions in establishments and surroundings with reference to the fly problem; experiments in the control and eradication of flies to be carried out in establishments at Dallas, Tex., and elsewhere.

Cooperation.—Bureau of Entomology.

Location.—Washington, D. C., Dallas, Tex., and various meat-inspection stations.

Date begun.—1915.

Results.—Some of the best methods of trapping flies were determined, and instructions were issued in Service and Regulatory Announcements for January, 1916.

Probable date of completion.—1918.

Assignment.—G. H. Shaw.

Proposed expenditures, 1916-17.—\$1,000.

Total, Control of Meats and Meat Food Products, \$3,493,760, including \$149,260 statutory (regulation, \$3,466,760; research, \$27,000).

MEAT-INSPECTION STATIONS.

Location.	Character of work. ¹	Date begun.	Assignment.	Proposed expenditures, 1916-17.
Albany, N. Y.	A, B, C, D, G	1909	E. H. Baumann	\$9,656
Albert Lea, Minn.	A, B, C, D, G	1914	G. W. Knorr	7,579
Allentown, Pa.	A, B, C, D, G	1906	N. C. Powell	8,012
Alton, Ill.	A, B, C, D, G	1906	Jas. Johnston	4,132
Arkansas City, Kans.	A, B, C, D, G	1906	J. E. Shelton	3,216
Auburn, Me.	A, B, C, D, G	1906	L. K. Green	2,840
Augusta, Ga.	A, B, C, D, F, G, H	1903	J. E. Lovejoy	13,832
Austin, Minn.	A, B, C, D, F, G, H	1901	E. W. Barthold	18,357
Baltimore, Md.	A, B, C, D, E, F, G, H	1904	H. A. Hedrick	47,540
Bellows Falls, Vt.	A, B, C, D, G	1912	T. W. Carnachan	2,705
Bisbee, Ariz.	A, B, D	1915	R. F. Krenek	1,600
Boston, Mass.	A, B, C, D, E, F, G, H	1895	J. F. Ryder	91,688
Bridgeport, Conn.	C, D, H	1909	J. F. Riemer	1,360
Brooklyn, N. Y.	A, B, C, D, E, F, G, H	1895	A. Long	40,575
Buffalo, N. Y.	A, B, C, D, F, G, H	1892	B. P. Wendt	69,361
Burlington, Vt.	A, B, C, D, G, H	1906	C. C. Conley	2,016
Cedar Rapids, Iowa	A, B, C, D, G	1896	F. Jelen	26,381
Cheyenne, Wyo.	A, B, C, D, G	1907	A. T. Knowles	3,180
Chicago, Ill.	A, B, C, D, F, G, H, I	1891	W. N. Neil	524,821
Cincinnati, Ohio	A, B, C, D, G, H	1895	D. C. Burnett	85,179
Cleveland, Ohio	A, B, C, D, F, G, H	1892	H. H. George	72,703
Columbus, Ohio	A, B, C, D, G	1906	O. W. Everly	5,723
Cortland, N. Y.	A, B, C, D, G, H	1906	A. F. Staub	8,812
Cumberland, Md.	C, D, G	1903	J. C. Shafer	1,320
Davenport, Iowa	A, B, C, D, F, G	1896	F. W. Miller	5,018
Dayton, Ohio	A, B, C, D, G	1906	F. L. Gardner	13,127
Denver, Colo.	A, B, C, D, F, G	1903	J. C. Exline	33,955
Detroit, Mich.	A, B, C, D, E, F, G	1899	E. P. Schaffter	38,315
Dubuque, Iowa	A, B, C, D, G	1906	W. C. Bower	3,283
Duluth, Minn.	A, B, C, D, E, G	1903	Chester Miller	4,554
Eau Claire, Wis.	A, B, C, D, G	1899	W. Fotheringham	4,424
El Paso, Tex.	C, D, E, G	1907	W. A. Kessler	5,008
Evansville, Ind.	A, B, C, D, G	1906	L. Metsker	5,808
Fargo, N. Dak.	C, D, G	1909	E. H. Clark	1,320
Faribault, Minn.	A, B, C, D, G	1913	T. W. Scott	1,800
Fergus Falls, Minn.	A, B, C, D, G	1907	M. L. Davenport	1,920
Fort Smith, Ark.	C, D, G	1909	W. B. Nichols	1,320
Fort Wayne, Ind.	A, B, C, D, G	1906	J. Miller	4,932
Fort Worth, Tex.	A, B, C, D, G, H	1902	A. O. Lundell	70,326
Grand Rapids, Wis.	A, B, C, D, G	1909	F. O. Kickbusch	2,980
Hallstead, Pa.	A, B, D, G	1908	S. M. Page	1,981
Harrisburg, Pa.	A, B, C, D, G	1906	W. C. Siegmund	9,400
Hartford, Conn.	C, D, F, G, H	1906	W. E. Jennings	1,346
Haverhill, Mass.	A, B, C, D, F, G	1906	H. Q. Thompson	6,681
Houston, Tex.	A, B, C, D, G, H	1906	C. F. Palmer	11,960
Huntington, W. Va.	A, B, C, D	1916	E. B. Jansman	1,900
Indianapolis, Ind.	A, B, C, D, G	1892	G. W. Butler	66,729
Jacksonville, Ill.	A, B, C, D, G	1906	J. B. Clancy	3,200
Jefferson, Wis.	A, B, C, D, G	1906	Geo. Jerome	1,918
Jersey City, N. J.	A, B, C, D, E, F, G, H	1891	R. M. Mullings	43,841
Kansas City, Kans.	A, B, C, D, E, F, G, H, I	1891	J. Fleming	279,932
La Crosse, Wis.	A, B, C, D, G	1906	R. E. Christopher	4,029
La Fayette, Ind.	A, B, C, D, G	1906	C. H. Herrold	4,400
Lewiston, Idaho	A, B, C, D, G	1907	L. B. Dunlap	3,074
Logansport, Ind.	A, B, C, D, G	1906	John Keppel	5,486
Los Angeles, Cal.	A, B, C, D, E, F, G, H	1896	G. T. Irons	37,376
Louisville, Ky.	A, B, C, D, F, G, H	1896	S. L. Bond	18,920
Madison, Ind.	A, B, C, D, G	1906	W. H. Timmons	1,982
Manchester, N. H.	C, D, F, G	1907	J. Hurley	1,499
Marshalltown, Iowa	A, B, C, D, G	1896	D. E. Collins	6,002
Mason City, Iowa	A, B, C, D, G	1904	C. J. Millen	8,896
Memphis, Tenn.	A, B, C, D, G, H	1906	J. O. F. Price	8,707
Menominee, Mich.	A, B, C, D, G	1911	S. S. Snyder	1,978
Milwaukee, Wis.	A, B, C, D, F, G, H	1891	A. F. Behnke	63,715
Morristown, Tenn.	A, B, C, D, G	1907	W. T. Conway	4,741
Moscow, Idaho	A, B, C, D, G	1911	F. A. Barber	1,802
Nashville, Tenn.	A, B, C, D, G	1904	W. B. Lincoln	6,832
Natchez, Miss.	A, B, C, D, G	1908	P. J. Huffman	10,101
National Stock Yards, Ill.	A, B, C, D, G, H, I	1892	E. L. Bertram	120,750
Nebraska City, Nebr.	A, B, C, D, G	1901	E. F. Haven	6,158
Newark, N. J.	A, B, C, D, F, G, H	1904	A. F. Martins	33,510
New Haven, Conn.	A, B, C, D, F, G, H	1899	R. O. Brock	9,142
New Orleans, La.	A, B, C, D, E, F, G, H	1906	R. W. Tuck	19,023

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MEAT-INSPECTION STATIONS—Continued.

Location.	Character of work. ¹	Date begun.	Assignment.	Proposed expenditures, 1916-17.
New York, N. Y.	A, B, C, D, E, F, G, H, I.	1891	N. L. Townsend	\$188,206
Norfolk, Va.	C, D, E, F, G.	1908	T. M. Owen	3,916
North Tazewell, Va.	A, B, C, D, G.	1913	O. J. Huth	3,323
Ogden, Utah.	A, B, C, D, G.	1906	E. D. Kennedy	5,675
Oklahoma, Okla.	A, B, C, D, G.	1906	J. S. Grove	45,076
Ottumwa, Iowa.	A, B, C, D, G.	1892	P. J. Brady	24,310
Paterson, N. J.	A, B, C, D, E, G.	1906	A. McBride	17,365
Peoria, Ill.	A, B, C, D, G.	1906	A. N. Hughes	9,843
Philadelphia, Pa.	A, B, C, D, E, F, G, H.	1893	C. A. Schaufler	85,883
Pittsburg, Kans.	A, B, C, D, G.	1906	J. E. Blackwell	2,000
Pittsburgh, Pa.	A, B, C, D, G, H.	1892	G. E. Totten	34,200
Portland, Me.	A, B, C, D, F, G, H.	1896	F. W. Huntington	8,685
Portland, Oreg.	A, B, C, D, F, G, H.	1897	E. C. Joss	22,267
Pottsville, Pa.	A, B, C, D, G.	1906	G. H. Woolfolk	6,000
Providence, R. I.	A, B, C, D, E, F, G, H.	1906	H. M. Smith	26,167
Pueblo, Colo.	A, B, C, D, G.	1906	B. F. Gooch	4,112
Quincy, Ill.	C, D, F, G.	1908	L. H. Howlett	1,320
Reno, Nev.	A, B, C, D, F, G.	1906	J. H. Webster	3,716
Richland Center, Wis.	A, B, C, D.	1915	L. H. Allen	2,000
Richmond, Ind.	A, B, C, D, G.	1906	C. O. Wagoner	2,746
Richmond, Va.	A, B, C, D, F, G.	1906	H. Marshall	15,137
Rochester, N. Y.	C, D, E, G.	1906	P. W. Campbell	1,324
St. Louis, Mo.	A, B, C, D, F, G, H.	1895	F. J. Brougham	66,729
Salt Lake City, Utah.	C, D, G.	1906	F. E. Murray	2,012
San Diego, Cal.	A, B, C, D, E, F, G, H.	1901	W. M. MacKeller	7,068
San Francisco, Cal.	A, B, C, D, E, F, G, H, I.	1895	H. H. Hicks	30,812
Seattle, Wash.	A, B, C, D, E, F, G, H.	1900	J. Madsen	29,593
Shreveport, La.	C, D, G.	1908	L. Bryant	2,160
Sioux City, Iowa.	A1B, C, D, G.	1894	T. A. Shipley	78,220
Sioux Falls, S. Dak.	A, B, C, D, G.	1906	E. S. Dickey	17,812
South Omaha, Nebr.	A, B, C, D, E, F, G, H, I.	1891	H. Busman	180,558
South St. Joseph, Mo.	A, B, C, D, F, G, H.	1898	M. O. Anderson	109,194
South St. Paul, Minn.	A, B, C, D, G.	1895	F. D. Ketchum	44,523
Spokane, Wash.	A, B, C, D, G.	1906	R. W. Culbert	18,487
Springfield, Mass.	C, D, F, G.	1906	H. E. Brown	14,747
Stamford, Conn.	C, D.	1913	F. W. Hellriegel	1,200
Tacoma, Wash.	A, B, C, D, G, H.	1904	F. Loman	10,833
Terre Haute, Ind.	A, B, C, D, G.	1912	C. B. Weagly	5,581
Texarkana, Tex.	C, D, G.	1913	H. G. Potter	1,335
Topeka, Kans.	A, B, C, D, G.	1901	F. S. Bingham	8,133
Walla Walla, Wash.	A, B, C, D, G.	1907	Wm. Hamilton	5,047
Washington, D. C.	A, B, C, D, E, F, G, H.	1906	H. K. Walter	18,510
Waterloo, Iowa.	A, B, C, D, G.	1900	F. T. Suit	8,817
Watertown, S. Dak.	(Inspection suspended).	1913	R. G. Rice	.....
Wausau, Wis.	A, B, C, D.	1916	R. J. Dignan	2,800
West Toledo, Ohio.	A, B, C, D, G, H.	1906	S. W. Burt	8,800
Wheeling, W. Va.	A, B, C, D, F, G.	1906	C. F. Payne	18,786
Wichita, Kans.	A, B, C, D, G.	1897	J. S. Kelly	41,682
Wilmington, Del.	A, B, C, D, F, G.	1906	G. E. Repp	6,444
Winona, Minn.	A, B, C, D, G.	1907	W. J. Fretz	6,200
Worcester, Mass.	A, B, C, D, F, G, H.	1898	M. T. Perry	10,469
Total Meat-Inspection Stations.				23,327,512

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² The expenses of 118 substations, not separately reported, are included in this amount. This total includes \$90,920 statutory salaries.

BUREAU OF PLANT INDUSTRY.

GENERAL ADMINISTRATION.

Office of Chief:

Object.—The effective administration of the affairs of the Bureau of Plant Industry and general direction of all of its investigational activities.

Cooperation.—Other offices of the department, other departments, and State experiment stations.

Location.—Washington, D. C.

Date begun.—1900.

Assignment.—William A. Taylor, chief; K. F. Kellerman, assistant chief.

Proposed expenditures, 1916-17.—\$27,460.

Office of Chief Clerk:

Object.—General supervision of the clerical force and janitor service of bureau, purchase of supplies and equipment, handling mail, operation and maintenance of central file room and property room, and all matters pertaining to appointments, pay rolls, and leaves of absence.

Cooperation.—Other offices of the department and other departments.

Location.—Washington, D. C.

Date begun.—1900.

Assignment.—James E. Jones.

Proposed expenditures, 1916-17.—\$37,380.

Editorial Work:

Object.—To edit and prepare for printing manuscripts and to read and revise proofs of articles submitted for publication by investigators of the bureau; also similar work in connection with all printing required by the bureau.

Cooperation.—Other bureaus of the department and the Division of Publications.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—J. E. Rockwell.

Proposed expenditures, 1916-17.—\$7,870.

Accounts:

Object.—The systematic administration of the fiscal affairs of the bureau.

Cooperation.—Disbursing office of the department; the Treasury Department.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—W. P. Cox.

Proposed expenditures, 1916-17.—\$23,130.

Library:

Object.—To maintain a working reference collection of the department books on botany; to furnish to the bureau scientists bibliographical assistance in the use of the library resources of the department and of those of other libraries in and outside of Washington; to maintain mailing lists for publications and do other work for the bureau for which a knowledge of the department library methods and botanical bibliography is essential.

Procedure.—Records of books in use are kept in accordance with the system employed by the department library. Current periodicals are circulated regularly, with a follow-up system to insure prompt service. Current phytopathological literature is indexed, and reference and bibliographical work is done as need develops. References appearing in bureau publications and in the Journal of Agricultural Research are edited according to approved rules. Records are kept of books purchased on bureau funds for field stations. A central mailing list, domestic and foreign, is maintained.

Cooperation.—Department library and branch libraries, Library of Congress, and other libraries in and outside of Washington.

Location.—Washington, D. C.

Date begun.—1900.

Assignment.—Eunice R. Oberly.

Proposed expenditures, 1916-17.—\$8,040.

Total, General Administration, \$103,880, including \$72,860 statutory (research, \$68,880; extension, \$18,000; regulation, \$17,000).

[Research.]

LABORATORY OF PLANT PATHOLOGY.

GENERAL LABORATORY INVESTIGATIONS.

General Laboratory Investigations:

Object.—To ascertain the life history of fungi and bacteria parasitic on plants, with a view to discovering means of prevention and remedies for various diseases.

Procedure.—The work involves microscopic examination of diseased material in fresh condition and also when embedded in paraffin and stained; isolation of organisms from the diseased tissues and study of their life histories on various culture media; inoculation experiments in the hothouses and elsewhere; testing various fungicides, germicides, etc.; field study when the cases are serious enough to warrant it.

Cooperation.—Usually entirely within the department; occasionally cooperative experiments are undertaken in certain localities.

Location.—Washington, D. C., and at any point in the field when conditions demand personal attention.

Date begun.—1901.

Results.—(1) Prior to 1916: Many plant diseases have been studied, carefully worked out, and reported upon. It has been demonstrated that the wilt of tobacco in this country is due to the same organism as that causing the wilt of tomatoes, potatoes, and eggplants, and that certain other plants are subject to this disease, as, for example, the cultivated nasturtium.

It has also been determined that the bacterial disease of sweet corn is generally distributed on the seeds and that the disease has been disseminated broadcast in this way, but that disinfection in mercuric-chloride water previous to planting greatly reduces the chances of a general infection of the crop, though it does not eliminate all the sources of danger, because a certain proportion of the seeds also contain bacteria in their interior where the germicide can not reach them. As these are likely to be dwarfed seeds, it is advised that previous to the germicidal treatment all the small, defective kernels be screened out and destroyed. The most effective way, however, to deal with this disease would be for the seedsmen to grow their sweet corn on land free from the disease and to sell only crops known by them to be free from the disease.

(2) During 1916: The newer studies on crown gall are considered to be the most important results obtained thus far in the fiscal year 1916. These have demonstrated that with the same organism used to produce ordinary crown gall an entirely new type of tumor can be produced if inoculations are made in the vicinity of dormant buds and even in some cases in the middle of leaves where no dormant buds are known to occur. This is a complex type of tumor containing leafy or flower shoots and in the depth of the tumor embryonic fragments of various organs, thus correlating it with the most complex malignant tumor occurring in animals, namely, the embryonal teratomas.

One of the most important practical results recently obtained is the discovery that the organism causing the bacterial wilt of cucurbits is carried over winter in the bodies of certain of the striped cucumber beetles and that when plants are protected from the depredations of these beetles they remain free from the disease in fields which are badly attacked by it. The only conclusion to be drawn, therefore, is that when proper methods have been devised for the control of these insects the cucurbit wilt will cease to be a serious trouble to growers.

Assignment.—Erwin F. Smith.

Proposed expenditures, 1916-17.—\$24,183, including \$5,880 statutory.

SPECIAL INVESTIGATIONS.

Diseases of Pond Lilies:

Object.—To establish the causes and work out life histories and the control of diseases of pond lilies.

Procedure.—Cultural studies of the causal organisms and inoculation experiments in greenhouse, laboratory, and field are made to establish causal relations and life histories. Control spraying experiments, which have already given promise of results, will possibly also be continued.

Location.—The principal part of the investigation of this project will be carried out in the District of Columbia, but collecting and observation trips may be necessary in the neighborhood of Greenport (Long Island), N. Y.

Diseases of Pond Lilies—Continued.

Date begun.—1913.

Results.—Prior to the inauguration of this project no cultural or inoculation work had been found on record concerning any of the parasitic diseases of pond lilies. Several years ago a series of spray tests was conducted by the New Jersey Experiment Station against a leaf disease apparently due to a *Cercospora*, but no cultural studies or inoculation work were recorded. Spraying experiments, cultural studies, and inoculation work were begun by the leader of this project during the summer of 1913 on a *Heliocoosporium* leaf disease doing considerable damage at the aquatic gardens of Mr. W. B. Shaw, Kenilworth, D. C. The work upon this serious disease is now completed and ready for publication. Study is also now being made of several other fungous diseases of pond lilies and of a rather serious fungous leaf-spot of lotus. Work upon the latter is nearly completed.

Probable date of completion.—January, 1917.

Assignment.—Frederick V. Rand.

Proposed expenditures, 1916-17.—\$430.

Control of Bacterial Wilt of Tobacco:

Object.—To determine means of preventing and eradicating the bacterial wilt disease of tobacco.

Procedure.—An attempt will be made to take advantage, on the one hand, of certain weaknesses of the parasite which have been discovered and, on the other hand, of the fact that certain methods of soil management appear to render tobacco particularly susceptible to wilt. New methods of cultivation and of soil treatment that appear likely to weaken the parasite and to strengthen the host are being tried. The field work will be checked up by similar experiments in laboratory and greenhouse, where more exact control of conditions is possible, so as to determine the basic principles involved in the control of the disease.

Cooperation.—Laboratory and greenhouse experiments are conducted without cooperation. The field experiments are conducted in cooperation with the American Sumatra Tobacco Co.

Location.—Laboratory and greenhouse work in Washington, D. C.; field experiments in Gadsden County, Fla., and later possibly at other points in Florida, as well as in Georgia.

Date begun.—1912.

Results.—The field work on this project is only in its second season. The results of the first season, while not conclusive, seem to indicate the possibility of controlling this disease.

Probable date of completion.—1918.

Assignment.—R. E. B. McKenney.

Proposed expenditures, 1916-17.—\$5,000.

Alternaria Leaf Disease of Cucurbits:

Object.—To complete the life-history work on the causal organism (*Alternaria brassicae* var. *nigrescens* Peglion) and to devise methods of control for the disease.

Procedure.—The investigation comprises cultural studies of the causal organism and inoculation experiments to further work out the life history and biological relations of the organism.

Location.—Laboratory and greenhouse experiments on this project are being carried out in Washington, D. C.; field observations and experiments were conducted in the neighborhood of Greenport (Long Island), N. Y., during the seasons of 1915-16; in addition, observations in connection with other field trips have been made through Maryland, Delaware, New Jersey, Michigan, Wisconsin, Indiana, and Iowa.

Date begun.—1892.

Results.—Successful cultural studies and inoculations have been carried out, but the work is not completed. Under this project considerable cultural and inoculation work has already been done and field observations made since August, 1914.

Probable date of completion.—January, 1918.

Assignment.—Erwin F. Smith.

Proposed expenditures, 1916-17.—\$1,752.

Bacterial Wilt of Cucurbits:

Object.—To further investigate the biological and soil relations of the causal organism (*Bacillus tracheiphilus* Erwin F. Smith), to devise methods of control for the disease, and to further ascertain its distribution.

Procedure.—The investigation comprises cultural studies of the causal organism, and inoculation experiments in greenhouse and field relative to further working out the biological relations of the organism, such as questions regarding physiological strains on the various hosts, methods of infection, viability in the soil and in animal parasites, and in seed of infected fruit, with special reference to ascertaining the manner in which the bacteria winter over. A histological and cytological study of the relation between host and parasite will also be made.

Cooperation.—Field experiments during the seasons of 1915–16 were carried out through cooperation with growers in an infected locality. This work also has been prosecuted in mutual cooperation with the Office of Cotton, Truck, and Forage-Crop Disease Investigations in connection with its work in the Middle West on some other diseases of cucurbits.

Location.—The principal investigations under this project have been conducted in the Laboratory of Plant Pathology at Washington and in the neighborhood of Greenport (Long Island), N. Y. Collecting and observation trips were made through Maryland, Delaware, New Jersey, Michigan, Wisconsin, Indiana, and Iowa.

Date begun.—1914.

Results.—(1) Prior to 1916: The organism causing this disease was investigated by Dr. Erwin F. Smith and reported in *Centralblatt für Bakteriologie*, Band I, 1895, No. 9/10. After further study Dr. Smith published a monograph of the disease in 1911 (see "Bacteria in Relation to Plant Diseases," vol. II, pp. 209–299). Some of the results of Mr. Rand's investigations were published in his article entitled "Dissemination of Bacterial Wilt of Cucurbits," which appeared in the *Journal of Agricultural Research*, vol. 5, No. 6, Nov. 8, 1915.

(2) During 1916: The summer transmission by *Diabrotica* spp. has been further confirmed and the implication of these insects as winter carriers experimentally demonstrated. Successful control of the disease has been effected by a spray combining bactericidal, insecticidal, and repellent properties. Stomatal infections were found not to occur. Various insects other than *Diabrotica* have given negative results as carriers of bacterial wilt. Some of the results of the more recent studies are presented in an article entitled "Transmission and Control of Bacterial Wilt of Cucurbits," published in the *Journal of Agricultural Research*, vol. 6, No. 11.

Probable date of completion.—January, 1918.

Assignment.—Frederick V. Rand.

Proposed expenditures, 1916–17.—\$4,365.

Total, Special Investigations, \$11,547.

Total, Laboratory of Plant Pathology, \$35,730, including \$5,880 statutory.

[Research.]

PATHOLOGICAL COLLECTIONS.**Pathological Herbarium:**

Object.—To maintain a collection of fungi demonstrative of the important economic bearing of fungi upon agricultural crops. The specimens comprising the herbarium are arranged with a view to assist mycological and pathological investigators in solving research problems or in the practical application of such problems.

Procedure.—Valuable pathological or mycological material is acquired by the purchase of American and foreign sets of exsiccati. Specimens identified by members of the office for mycologists, pathologists, collaborators, amateur collectors, or correspondents are retained, and other specimens are secured through the medium of the mycological exchange, through the deposition of type material by authors, through the agency of the Plant Disease Survey, and by collections made by members of the office staff.

Location.—Washington, D. C.

Date begun.—1885.

Pathological Herbarium—Continued.

Results.—The pathological collections now have 38 fire, insect, and dust proof cases for the accommodation of specimens, which number over 78,000 mounted specimens, exclusive of permanent microscopic slides. Approximately 3,000 specimens were inserted in the herbarium during the past fiscal year. Many of the foreign and domestic sets of exsiccati have been purchased by the herbarium, but owing to the very limited funds and the increase in the price of specimens due to the European war the office has been unable to secure certain very rare and important sets. The following sets have been acquired by the herbarium during the present year: Baker—Fungi Malayana, Centuries 1 and 2, 200 specimens; Bartholomew—Fungi Columbiani, Centuries 47–48, 200 specimens; Bartholomew—North American Uredinales, Centuries 15–16, 200 specimens; Brenckle—Fungi Dakotenses Fascicles 13–15, 75 specimens; Kabat and Bubak—Fungi imperfecti exsiccati, Fascicle 17, 50 specimens.

Assignment.—Flora W. Patterson.

Proposed expenditures, 1916–17.—\$3,992.

Mycological Index and Host Index:

Object.—To provide information relative to new genera or species; to furnish data regarding the geographical distribution of diseases, their intensity, and measures of control or eradication.

Procedure.—This project includes two distinct lines of work, one pertaining to the herbarium as furnishing an inventory of the fungi comprising the herbarium and their respective hosts, and the other providing abstracts, translations, and illustrations of new, contested, or imperfectly known genera, species, or diseases.

Location.—Washington, D. C.

Date begun.—1885.

Results.—The conspicuous activity in mycological and pathological lines has resulted in the acquisition of a large number of cards referring to these subjects. As in past years the following general divisions have been observed: Indexing of all new genera, including the generic diagnosis, a copy of the illustrations, and author's notes or comments; indexing of new species, both American and foreign; geographical index with special reference to the indiginity of species; nomenclatorial index pertaining to common names of fungi and fungous and physiological diseases of all countries and in all languages; subject index, consisting of references to and abstracts from all pathological and mycological subjects, whether of a technical, general, or semipopular nature, particular attention being given to diseases the causal organisms of which have not been determined, and the addition of several thousands of cards to the indexes as a result of this work.

Assignment.—Flora W. Patterson.

Proposed expenditures, 1916–17.—\$1,778.

Mycological Exchange:

Object.—To exchange mycological specimens with educational institutions and interested private individuals with the view of promoting general dissemination of economic mycological and pathological information.

Procedure.—Specimens are sent from the mycological exchange to experiment stations, agricultural institutions, collaborators, demonstrators, teachers of agriculture in secondary schools, and others especially interested in the economic study of fungi. This phase of the subject has been educational in character, but by the exchange of specimens with foreign mycologists much interesting material has been received by the office.

Location.—Washington, D. C.

Date begun.—1898.

Results.—In many young institutions or in those having limited equipment the exchanges furnished by this office have served as valuable nuclei for pathological collections and demonstration purposes.

Assignment.—Flora W. Patterson.

Proposed expenditures, 1916–17.—\$2,510.

Work of Identification:

Object.—The determination of fungi, in order to discover the causal agent of disease and thus enable the pathologist to devise or recommend measures for control.

Procedure.—This work may be considered under two heads—pathological identification and mycological identification. Under pathological identifications are included the determination of species of fungi causing diseases of plants.

Work of Identification—Continued.

Microscopic examinations are often sufficient for the solution of problems connected with well-established diseases, but new diseases always require a study of the life history of the causal organisms and relation to fungi already recognized as pathogenic. These identifications frequently require cultural work, critical microscopic comparisons with authentic specimens, and inoculation experiments. Under mycological identifications may be understood the determination of fungi of taxonomic rather than pathological interest. The value of this work is constantly recognized, as field observations often reveal the parasitic nature of fungi at first supposed to be of systematic interest only.

Location.—Washington, D. C.

Date begun.—1885.

Results.—(1) During 1916: One of the most important results of the work during the past year was the issuance of a publication (Department Bulletin 175) on the subject of edible and poisonous species of mushrooms and other common fungi. Although principally designed for amateurs, this bulletin has been endorsed as a class book in certain collegiate institutions. It contains descriptions and notes on 159 species, with 86 illustrations. The demand for this publication has been so heavy that the office has been instructed to prepare a Farmers' Bulletin on the subject of common poisonous and edible species of fungi, which will be written in popular style and will be less technical in character.

An illustrated article entitled "Mushrooms and Other Common Fungi" was prepared in the office for the Boy Scout Manual. This paper was written with the purpose of interesting and instructing the scout as to the common species and was therefore brief and nontechnical in character.

A paper entitled "Occurrence of Bamboo Smut in America" has been prepared for publication in Phytopathology. The article includes notes on the history, nature, and seriousness of the disease in China and a discussion of the microscopic character of the fungus and its occurrence and status in America.

The taxonomic investigations of fungi on sugar cane in Porto Rico have been completed. Over 100 specimens were studied, some being undescribed species. This work was done in the interest of the Sugar Producers' Association of Porto Rico.

Two large sets of Alaskan fungi have been determined by the office, one for the National Museum and one for Prof. L. H. Pammel, of the Iowa State College of Agriculture, Ames, Iowa. The determination of these sets was very important because little is known concerning the fungus flora of this region.

(2) Prior to 1916: From 1898 until February, 1915, the office was responsible for the pathological inspection of all departmental and congressional plant material, including all foreign importations and domestic distributions. In connection with the foreign importations, a large number of new species and several new genera were detected and the introduction of new parasites thus prevented. In February, 1915, the inspection work, both entomological and pathological, was reorganized and placed under the control of the Federal Horticultural Board.

Among the important economic fungi first noted, identified, or described by this office may be mentioned the chestnut blight disease; *Chrysophlyctis*, the wart disease of potato; *Kavakamia cyperi* on sedge; *Loculistroma bambusae* Patterson and Charles on bamboo; *Peronospora* and *Physoderma* species on corn; *Botryosphaeria marconii* (Cav.) Charles and Jenkins on hemp, the cause of a serious disease of this crop; *Ustilago shiraiana*, producing witches' broom of bamboos; *Septoria spadicea* Patterson and Charles, associated with the physiological blight of white pine; and *Stemphylium tritici* Patterson, the causal agent in the sterility of wheat.

During several seasons the office made extensive investigations of *Mycogone perniciosa*, the serious European disease of cultivated mushrooms. The fungus causing the disease was studied in the laboratory and in mushroom beds and as a result of such study a method has been devised for its control. The results of this work were published in Department Bulletin 127. The directions for control are followed by many mushroom growers.

Assignment.—Flora W. Patterson, Vera K. Charles, Anna E. Jenkins.

Proposed expenditures, 1916-17.—\$3,730.

Total, Pathological Collections, \$12,010, including \$3,360 statutory.

[Research.]

FRUIT-DISEASE INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To handle administrative, clerical, and such service and laboratory work as pertains more or less to all the fruit-disease projects.

Cooperation.—Bureau of Entomology, Insecticide and Fungicide Board, and Federal Horticultural Board.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—M. B. Waite.

Proposed expenditures, 1916-17.—\$8,480, including \$5,180 statutory.

GENERAL ORCHARD DISEASES.**Pear-Blight Investigation and Eradication:**

Object.—To complete the knowledge of pear blight by working out further details; to improve methods of control already devised, and to demonstrate to orchardists, inspectors, and others the best methods known; to breed pears and apples resistant to this disease, including stocks on which to graft other varieties.

Procedure.—Laboratory work, microscopical and bacteriological, is conducted; also field investigations and experiments, mostly near by in Virginia and Maryland; eradication work in the orchards in various parts of the country, particularly in California, Washington, and Oregon; breeding work in the vicinity of Washington and at Arlington Farm, Va.

Cooperation.—Extensive cooperation in the field with State and county horticultural commissioners, fruit-tree inspectors, experiment-station workers, and orchardists, particularly on the Pacific coast.

Location.—Washington, D. C., Arlington Farm, Va., and orchards in various parts of the country, particularly in California, Washington, Oregon, Virginia, and Maryland.

Date begun.—1889.

Results.—A method of control by eradication has been discovered. This has been quite largely but not completely put into practice in different sections, particularly on the Pacific coast, and has resulted in saving the pear industry in California, Washington, and Oregon, and in benefits to other pear and apple sections.

Probable date of completion.—The research work has been practically completed, though certain phases, as the disease reappears each year, call for further detailed studies, particularly studies of infection methods and insect distribution of the disease. The date of completion of the eradication work and cooperation in control of the disease is somewhat indefinite.

Assignment.—M. B. Waite, L. M. Hutchins, E. A. Siegler.

Proposed expenditures, 1916-17.—\$2,000.

Little-Peach and Peach-Yellows Investigations:

Object.—To investigate the nature, distribution, and method of control of these diseases and to assist the various States in control work.

Procedure.—This project involves certain incidental laboratory studies, but principally field-service work in promoting the control.

Cooperation.—In control work, with various State and county horticultural inspectors.

Location.—Laboratory work, Washington, D. C.; field work, mainly control, probably in Michigan, New York, Pennsylvania, Connecticut, Virginia, and Maryland.

Date begun.—Begun by Erwin F. Smith in 1887; transferred to M. B. Waite in 1899.

Results.—The cause of these diseases has not yet been discovered. A practical method of control of peach yellows by eradication has been extensively promoted by this work. Little peach has been classified in the peach-yellows group and a practical method of control by eradication discovered and developed.

Assignment.—M. B. Waite, L. M. Hutchins.

Proposed expenditures, 1916-17.—\$400.

Crown-Gall of Fruits:

Object.—To make available to orchardists results of research; to aid nurserymen and orchardists in eliminating the disease; to carry on field tests for this purpose.

Procedure.—Assistance is rendered to nurserymen and orchardists to control the disease and to State and local horticultural inspectors by deciding doubtful cases. Field tests are conducted in propagating healthy trees, and observations are made on the behavior of diseased trees when planted in orchards.

Cooperation.—Nurserymen, orchardists, and various State and county horticultural inspectors.

Location.—Laboratory work, Washington, D. C.; service work, various orchard sections of the United States.

Date begun.—1900.

Results.—Important steps toward control in nurseries have been made. The results of the work of other investigators are made available to growers.

Assignment.—M. B. Waite.

Proposed expenditures, 1916-17.—\$400.

Pollination of Orchard Fruits:

Object.—To continue an old project by perfecting knowledge of certain details of pollination and fruit-setting problems.

Procedure.—Hand pollinations of blossoms are made in the orchards and the results studied.

Location.—Vicinity of Washington, D. C.

Date begun.—1890.

Results.—Important discoveries in self-sterility of fruits; improved methods of planting orchards to secure cross-pollination.

Probable date of completion.—The main project is already completed; certain points require further study.

Assignment.—M. B. Waite.

Proposed expenditures, 1916-17.—\$300.

Apple Cankers of the United States:

Object.—To determine the cause of and remedy for various apple cankers and to study the life history of the causal organisms.

Procedure.—Laboratory studies, both microscopical and cultural, are made of diseased material; field tests in eradication and control in orchards conducted.

Location.—Washington, D. C., and apple orchards in various States.

Date begun.—1903.

Results.—Accumulation of data; practical experience in control; service to a large number of fruit growers.

Assignment.—M. B. Waite.

Proposed expenditures, 1916-17.—\$1,500.

Apple Black Heart:

Object.—To find the cause of this disease and develop a remedy or control methods. This disease blackens the inside of the trunks of young apple trees, causing premature decay and often death. It often causes serious damage in the Middle Western States.

Procedure.—Laboratory studies, including bacteriological culture work, are carried on; also field examinations in various orchards and nurseries.

Location.—Principally in the Middle Western States; in Maryland and Virginia; laboratory work at Washington, D. C.

Date begun.—1903.

Results.—Preliminary bacteriological researches have been made. Crown gall and other organisms have been found associated with the disease.

Assignment.—M. B. Waite.

Proposed expenditures, 1916-17.—\$300.

Apple and Peach Powdery Mildew:

Object.—To perfect methods of control of this disease in various sections of the country.

Procedure.—The work consists mainly of spraying experiments in the devising and testing of new fungicides.

Cooperation.—Entomologist of Santa Cruz County, Cal.

Location.—Watsonville, Cal., and Wenatchee, Wash.

Date begun.—1907.

Apple and Peach Powdery Mildew—Continued.

Results.—A practical method of control in the Watsonville, Cal., district, by spraying with iron-sulphide mixture, has been discovered; data published in Department Bulletin 120, "Apple Powdery Mildew and Its Control in the Pajaro Valley." A modification of these methods to adapt them to the general irrigated orchard sections is in process of development at Wenatchee, Wash.

Probable date of completion.—The main project has been completed for the Watsonville section, where only certain sprays can be used; for other sections, 1917.

Assignment.—W. S. Ballard, for California; Charles Brooks and D. F. Fisher, for Washington and Oregon.

Proposed expenditures, 1916-17.—\$500.

Shot-Hole and Twig-Spot of Peaches and Apricots:

Object.—To differentiate the various diseases, including the gumming fungus of the peach, which is the principal one; to find the cause of the apricot spot and remedies for the same.

Procedure.—Laboratory and field studies are conducted, including spraying experiments.

Cooperation.—Fruit growers.

Location.—California.

Date begun.—1905.

Results.—A perfect spraying remedy has been found for the peach gumming fungus; control measures for apricot disease not yet perfected.

Probable date of completion.—Main project on the peach practically completed, on the apricot, 1918.

Assignment.—M. B. Waite, W. S. Ballard.

Proposed expenditures, 1916-17.—\$200.

Nut Diseases:

Object.—To find causes of and remedies for various nut diseases and to develop control measures.

Procedure.—The usual laboratory and field investigations are carried on, the work being particularly concerned with a study of pecan diseases; also an investigation of the diseases of the English walnut and filbert in the eastern United States and some control experiments on English-walnut diseases on the Pacific coast.

Cooperation.—Nut growers.

Location.—Washington, D. C.; field work on pecan diseases, at Thomasville, Albany, and Cairo, Ga., and on English walnut and filbert diseases, in Virginia, Maryland, Delaware, Pennsylvania, and New Jersey.

Date begun.—1909.

Results.—A thorough study has been made of pecan scab and certain other fungous diseases, including methods of control, and remedies devised for certain pecan-leaf diseases by spraying in the nursery and orchard. The knowledge of pecan diseases is being rapidly built up.

Assignment.—S. M. McMurran.

Proposed expenditures, 1916-17.—\$2,800.

Root-Rot Diseases of Fruit Trees:

Object.—To ascertain causes, life history, and methods of dissemination of the fungi responsible for root-rot diseases of fruit trees and to develop control or remedial measures.

Procedure.—This project involves laboratory work, including microscopical examinations and cultures; study of diseased trees in the orchards and of diseased nursery stock; inoculation tests and pathological investigations.

Cooperation.—Federal Horticultural Board and various horticultural inspectors over the country in the identification of material.

Location.—Washington, D. C. These diseases occur all over the United States.

Date Begun.—1900.

Results.—Data and specimens accumulated, but no remedy found as yet.

Assignment.—M. B. Waite.

Proposed expenditures, 1916-17.—\$1,000.

Frost Injuries to Fruit Trees:

Object.—To apply pathological methods to the study of frost injuries.

Procedure.—Frost injuries are followed up as they occur in different sections of the United States. The tissues are examined microscopically and sometimes bacteriological cultures are made. Data and observations, drawings, and photographs of frost injuries and records of weather conditions which produce them are accumulated. Field studies are made on the behavior of fruit trees injured in varying degrees as frosts occur.

Frost Injuries to Fruit Trees—Continued.

Cooperation.—Fruit growers, nurserymen, cold-storage houses, and fruit-tree inspectors.

Location.—Washington, D. C.; field work in orchards at various points.

Date begun.—1890.

Results.—A better understanding of the injuries to fruit and fruit trees and of methods of handling frost-injured trees has been obtained.

Assignment.—M. B. Waite.

Proposed expenditures, 1916-17.—\$700.

Spraying Apparatus and Spraying Efficiency:

Object.—To investigate in orchards the relative efficiency of the many types of spraying apparatus now on the market when in actual use in the control of diseases. Attention will be given to the most economical types of spraying apparatus for given kinds of work and service. An estimate of spraying efficiency as practiced by various orchardists, vineyardists, etc., will be made as a basis for suggestions in improvement in such work.

Procedure.—Different types of spraying machinery in operation in orchards will be observed, to determine their comparative value and efficiency under varying orchard and farm conditions. In this connection observations will be accumulated on the efficiency of the work as accomplished by different individuals, and special inquiries will be made to determine wherein spraying operations do not give entirely satisfactory results in the control of diseases.

Cooperation.—This work is carried on in cooperation with the Bureau of Entomology and the Office of Public Roads and Rural Engineering. The strictly engineering and mechanical work is conducted by the Office of Public Roads and Rural Engineering. Cooperative arrangements have been made between these three bureaus with reference to the conduct of this work.

Location.—Washington, D. C.; spray-apparatus factories, and orchards and vineyards in various parts of the country.

Date begun.—Actually begun in 1886; taken up by the present leader in 1892; formulated as a joint cooperative project in 1915.

Results.—The work in past years has resulted in many detailed improvements, which have been utilized especially as suggestions to manufacturers and orchardists; information in Farmers' Bulletins 243, 284, 440, and 492.

Assignment.—M. B. Waite.

Proposed expenditures, 1916-17.—\$500.

Fungicides for Fruit Diseases:

Object.—To improve fungicides and methods of mixing the same; to study their direct effect on fruits and fruit trees, especially their injurious effects, and their efficiency in disease control; and to study combinations of fungicides with insecticides.

Procedure.—Experiments in mixing and compounding various fungicides are carried on in the laboratory and in the field, particularly in connection with field spraying experiments.

Cooperation.—Bureau of Entomology, Insecticide and Fungicide Board, Bureau of Chemistry, orchardists, and manufacturers of fungicides.

Location.—Washington, D. C.; field stations and orchards at Watsonville, Cal., Wenatchee and Vancouver, Wash., Bentonville, Ark., Vineland, N. J., and various other points.

Date begun.—Actually begun in 1886; taken up by the present leader in 1892.

Results.—Improvements are made annually in methods of mixing and applying fungicides and of combining them with insecticides.

Assignment.—M. B. Waite, C. L. Shear, Charles Brooks, John W. Roberts, W. S. Ballard, H. R. Fulton.

Proposed expenditures, 1916-17.—\$300.

Miscellaneous Orchard Diseases:

Object.—To investigate minor orchard diseases not covered in specific projects and diseases which suddenly assume importance.

Procedure.—The usual pathological methods are followed, including laboratory examinations, microscopic study, culture study, and field work.

Cooperation.—Fruit growers and horticultural inspectors.

Location.—Washington, D. C., and orchards over the United States.

Date begun.—1890.

Miscellaneous Orchard Diseases—Continued.

Results.—Data have been accumulated about special diseases and service rendered to orchardists and to State and experiment-station pathologists and horticultural inspectors through examination of specimens and correspondence. In the case of apple cedar rust important practical benefits have been derived through the promotion of control by the destruction of the red cedars.

Assignment.—M. B. Waite, L. M. Hutchins, E. A. Siegler.

Proposed expenditures, 1916-17.—\$3,875.

Total, General Orchard Diseases, \$14,775.

GRAPE AND SMALL-FRUIT DISEASES.**Cranberry Diseases:**

Object.—To investigate the cause, improve control and preventive methods, and study the habits and life histories of the causative organisms, with special reference to the blossom-end rot, black-spot, and other recently discovered troubles.

Procedure.—This work includes spraying experiments, field studies of new or recently discovered diseases, especially blossom-end rot, and the trial of various methods of reducing loss from rot after harvesting. The relation of methods of picking and handling to the development of rot between picking and marketing is being studied.

Cooperation.—Massachusetts Experiment Station.

Location.—Washington, D. C., Arlington Farm, Va., Massachusetts, New Jersey, Oregon, and Washington.

Date begun.—1901.

Results.—Additional knowledge of the organisms causing disease, their distribution, habits, and methods of control has been accumulated. Treatment of bogs by flooding with copper-sulphate solution indicates benefit in the keeping qualities of the fruit.

Assignment.—C. L. Shear.

Proposed expenditures, 1916-17.—\$3,500.

Grape Diseases:

Object.—To determine the cause, discover or improve control methods, and study the life histories and habits of the causative organisms.

Procedure.—Spraying experiments and laboratory investigations are conducted, relative varietal resistance studied, and cross-inoculation experiments made.

Cooperation.—New Jersey Experiment Station.

Location.—Washington, D. C., Arlington Farm and Vienna, Va., and Vineland, N. J.

Date begun.—1908.

Results.—Much additional knowledge of the organisms, their distribution, and control have been obtained.

Assignment.—C. L. Shear, R. B. Wilcox.

Proposed expenditures, 1916-17.—\$3,500.

Diseases and Rots Developing in Picking, Packing, and Transportation of Small Fruits:

Object.—To determine the organisms and conditions causing loss in picking, packing, and shipping and to develop methods for remedying such conditions.

Procedure.—The work consists of laboratory studies of the organisms involved, field studies of methods of picking, handling, and shipping, and experiments in the control of the diseases or removal of the causes.

Cooperation.—Growers and shippers.

Location.—Washington, D. C., and various small-fruit growing centers.

Date begun.—1915.

Results.—The effect of various methods of handling and shipping has been studied in Florida, showing that mechanical injury to fruit and high temperatures are the chief causes of decay in transit and on the market. Several fungi causing rot in the field, especially in strawberries, have been isolated and studied.

Assignment.—C. L. Shear, N. E. Stevens, R. B. Wilcox.

Proposed expenditures, 1916-17.—\$1,500.

Miscellaneous Small-Fruit Diseases:

Object.—To study fungous and physiological diseases of raspberries, blackberries, currants, gooseberries, and strawberries and methods of prevention or control.

Procedure.—Eradication and sanitary methods are followed, spraying experiments conducted, and laboratory and field studies of the organisms and conditions causing disease carried on.

Miscellaneous Small-Fruit Diseases—Continued.

Cooperation.—Small-fruit growers.

Location.—Washington, D. C., Arlington Farm and Vienna, Va., and Vineland, N. J.

Results.—This work has been productive of increased knowledge of the life histories of the parasites and their importance, distribution, and control.

Date begun.—1906.

Assignment.—C. L. Shear, R. B. Wilcox, N. E. Stevens.

Proposed expenditures, 1916-17.—\$3,000.

Total, Grape and Small-Fruit Diseases, \$11,500.

CITRUS AND SUBTROPICAL FRUIT DISEASES.**Citrus Canker:**

Object.—To find the cause of this disease, study the life history of the causative organism, and develop methods of control and extermination.

Procedure.—The usual bacteriological and pathological studies in the laboratory and in the field are carried on.

Cooperation.—Florida State officials and citrus growers and associations.

Location.—Florida and Gulf Coast States to Texas; Washington, D. C.

Date begun.—1914.

Results.—The distribution of the citrus-canker organism and its behavior in the field on various citrus hosts from Florida to Texas has been determined. The bacterial nature of the disease was discovered and proved by Clara H. Hasse in the laboratory and with greenhouse material at Washington. A paper on the subject was published in the *Journal of Agricultural Research*, vol. 4, No. 1, "Pseudomonas Citri, the Cause of Citrus Canker."

Assignment.—H. R. Fulton, Clara H. Hasse.

Proposed expenditures, 1916-17.—\$6,440.

Miscellaneous Citrus and Subtropical Fruit Diseases:

Object.—To find the causes of citrus and subtropical fruit diseases other than citrus canker, study the life histories of the organisms causing them, and develop methods for their control or extermination.

Procedure.—The usual pathological laboratory and field studies, including spraying experiments and tests of the effects of various methods of cultivation and fertilization on citrus diseases, are conducted.

Cooperation.—Citrus growers, mainly in Florida and the Gulf-coast districts.

Location.—Washington, D. C., temporary field laboratory at Orlando, Fla., and other points in Florida and on the Gulf coast.

Date begun.—Under old Division of Pathology, in 1892; later in the subtropical laboratory at Miami, Fla.; transferred to Fruit-Disease Investigations in 1908; present work actually inaugurated in 1912.

Results.—A preliminary study of citrus diseases has been made, and experiments are now under way.

Assignment.—H. R. Fulton, J. R. Winston.

Proposed expenditures, 1916-17.—\$8,600.

Total, Citrus and Subtropical Fruit Diseases, \$15,040, including \$600 statutory.

ORCHARD SPRAYING EXPERIMENTS.**Apple Bitter-Rot and Blotch Investigations:**

Object.—To obtain further information regarding the life histories of the fungi causing these diseases, especially as to the manner of wintering: to perfect and improve control methods by spraying and by eradicating the cankers.

Procedure.—This project involves the usual pathological and mycological studies in the field and laboratory and tests of control methods by spraying and eradication.

Location.—Virginia, Maryland, West Virginia, Arkansas, and Missouri.

Date begun.—Bitter-rot, 1903; blotch, 1906.

Results.—A successful treatment has been found for both diseases by late summer spraying with Bordeaux mixture and, under unfavorable conditions, by eradicating all cankers, including minor cankers and dead twigs in the winter. Data in *Farmers' Bulletin* 492 and *Journal of Agricultural Research*, vol. 4, No. 1, "Sources of the Early Infections of Apple Bitter-Rot."

Probable date of completion.—1920.

Assignment.—John W. Roberts.

Proposed expenditures, 1916-17.—\$2,300.

Peach and Plum Brown-Rot and Scab Investigations:

Object.—To determine the life histories of the organisms concerned and better means for their control.

Procedure.—Field spraying experiments are conducted; also the usual pathological and microscopical studies in the field and laboratory.

Cooperation.—Bureau of Entomology.

Location.—Washington, D. C., New Jersey, and Michigan.

Date begun.—1904.

Results.—The treatment of brown-rot and peach scab has been perfected and good results obtained on other stone fruits; data in Farmers' Bulletin 440.

Probable date of completion.—1917.

Assignment.—John W. Roberts.

Proposed expenditures, 1916-17.—\$950.

Apple Leaf Diseases:

Object.—To work out the life histories and the causes of the various fungous spots on apple foliage.

Procedure.—Pathological and mycological studies of the diseased spots, cultures to isolate the various fungi, and inoculation tests to study their results; also field spraying tests in connection with other spraying work.

Location.—Washington, D. C., and various orchards in Virginia, Arkansas, and other parts of the eastern half of the United States.

Date begun.—1909.

Results.—Several leaf diseases have been differentiated and proof of their cause by various fungi established. Improved methods in the control of these diseases in the orchards have been worked out. Data in Farmers' Bulletin 492 and Journal of Agricultural Research paper, "Experiments with Apple Leaf-Spot Fungi," vol. 2, No. 1.

Assignment.—John W. Roberts.

Proposed expenditures, 1916-17.—\$700.

Peach and Plum Bacteriosis:

Object.—To determine the nature of and remedy for the disease and the life history of the causative organisms.

Procedure.—Bacteriological laboratory studies are conducted, also field tests and experiments in eradication, spraying, and the use of special fertilizers.

Location.—Laboratory work at Washington, D. C.; in diseased orchards of Arkansas, Michigan, Georgia, and other States.

Date begun.—1902.

Results.—Preliminary bacteriological investigations have been made.

Assignment.—John W. Roberts.

Proposed expenditures, 1916-17.—\$650.

Development of Orchard-Spraying Methods:

Object.—To develop routine systems of spraying, particularly against apple and peach diseases; to test the use of combination sprays of insecticides and fungicides and spraying schedules; to test and demonstrate the treatment in various sections where for any cause failure has occurred.

Procedure.—Field experiments in the orchards are carried on in various parts of the country.

Cooperation.—Bureau of Entomology.

Location.—Benton Harbor and Hart, Mich., and various other points in the United States. The location changes each year.

Date begun.—1906.

Results.—Combined spraying schedules for the apple and peach in various sections have been perfected.

Assignment.—John W. Roberts.

Proposed expenditures, 1916-17.—\$1,200.

Total, Orchard Spraying Experiments, \$5,800.

FRUIT ROTS AND SPOTS.**Fruit-Spot of Jonathan and of Grimes and Other Yellow Apples:**

Object.—To determine the nature of the disease, its cause, and methods of prevention.

Procedure.—Irrigation and fertilizer experiments will be conducted in the orchards and a particular study made of apples after they are picked and when in transit, in storage, and on the market.

Fruit-Spot of Jonathan and of Grimes and Other Yellow Apples—Continued.

Location.—Washington, D. C., Wenatchee, Wash., and various other points in the United States.

Date begun.—1912.

Results.—Some of the orchard conditions which influence the amount of these diseases have been determined.

Assignment.—Charles Brooks, D. F. Fisher.

Proposed expenditures, 1916-17.—\$1,650.

Apple Bitter-Pit:

Object.—To determine the nature and cause of the disease and, as far as possible, methods of prevention.

Procedure.—A study will be made of the effect of nutrition, water supply, cultural methods, and various conditions of storage.

Location.—Wenatchee, Wash., Salem, Oreg., and various other points.

Date begun.—1909.

Results.—Data have been obtained that separates the disease from other closely-related troubles. Some of the orchard conditions which influence the development of the disease have been determined.

Assignment.—Charles Brooks, D. F. Fisher.

Proposed expenditures, 1916-17.—\$1,650.

Deciduous Fruit Rot Investigations:

Object.—To determine the causes of and remedies for rots of deciduous orchard fruits; especially to study these rots after picking time and when in transit, in storage, and on the market.

Procedure.—The characteristics of the rots and the fungi causing them are being investigated from both mycological and physiological points of view. A study is being made of the fungi at various temperatures.

Cooperation.—Insecticide and Fungicide Board.

Location.—Washington, D. C., Arlington Farm, Va., Vancouver and Wenatchee, Wash., and Salem, Oreg.; storage work, in various sections.

Date begun.—1888.

Results.—A large number of fungi have been isolated and their power to produce rots under various storage conditions determined. The blossom infection of brown rot on prunes and cherries has been found to be very extensive in the Columbia and Willamette valleys, and spraying experiments have shown the possibility of controlling the trouble under the conditions existing there.

Assignment.—Charles Brooks, J. S. Cooley, D. F. Fisher.

Proposed expenditures, 1916-17.—\$4,000.

Stigmonose of Deciduous Fruits:

Object.—To study the pathological changes in the tissues of deciduous fruits produced by the punctures and sucking of insects; to distinguish between the spots resulting from insect punctures and the physiological bitter-pit.

Procedure.—Fruit is obtained that is known to be punctured by particular insects, and a general and microscopic study of the effects is made.

Cooperation.—Bureau of Entomology.

Location.—Washington, D. C., Vienna and Staunton, Va., and Wenatchee, Wash.

Date begun.—1907.

Results.—The disease has been more clearly set off from bitter-pit and other related troubles, and some insects that are of importance have been determined and the effects they produce studied.

Assignment.—Charles Brooks, J. S. Cooley, D. F. Fisher.

Proposed expenditures, 1916-17.—\$500.

Total, Fruit Rots and Spots, \$7,800.

PHYSIOLOGICAL FRUIT DISEASES.**Nutrition in Relation to Fruit Diseases:**

Object.—To determine the effect of soil and subsoil constituents on diseases, including a study of the relation of artificial ingredients in the soil to orchard diseases; to study the causes of certain unknown diseases suspected of being caused by unfavorable environment.

Nutrition in Relation to Fruit Diseases—Continued.

Procedure.—Physiological and pathological methods are applied to the study of diseased orchards. The effect of climatic conditions, especially on the non-parasitic diseases, are studied. Investigation is made of soil conditions, chemical and mechanical, and the relation of soil moisture to certain diseases. The work involves both field and laboratory investigations.

Cooperation.—Fruit growers and horticultural commissioners and inspectors.

Location.—Washington, D. C., Watsonville, Cal., and field work mainly in the orchards of the semiarid and arid districts of the western United States.

Date begun.—1891.

Results.—Data accumulated regarding these little-known diseases; little-apricot trouble in Idaho identified as subsoil and irrigation difficulty; remarkable new discovery made of the benefits of winter spraying with nitrate of soda in California and work extended to Washington and Oregon; paper in Journal of Agricultural Research vol. 1, No. 5, "Winter Spraying with Solutions of Nitrate of Soda."

Assignment.—W. S. Ballard, E. M. Harvey.

Proposed expenditures, 1916-17.—\$3,500.

Chlorotic Diseases of Fruit Trees:

Object.—To discover the cause of and remedy for the various diseases of this class and to distinguish between the principal types.

Procedure.—The work includes laboratory and field investigations. Physiological and pathological methods are applied to the study of diseased orchards. The effect of climatic conditions on these diseases is studied. Soil and subsoil conditions, chemical and mechanical, and the relation of soil moisture to the diseases are investigated. Field investigation of the new disease known as "little leaf" of the peach in California, a supposedly physiological trouble, will be undertaken.

Cooperation.—Orchardists and State and county horticultural commissioners.

Location.—Washington, D. C., Watsonville, Cal., and States west of the one-hundredth meridian; on peach little-leaf, San Joaquin Valley.

Date begun.—1907.

Results.—Little is yet known about this difficult group of diseases; data accumulated as to nature and distribution of the maladies.

Assignment.—W. S. Ballard, E. M. Harvey.

Proposed expenditures, 1916-17.—\$2,500.

Total, Physiological Fruit Diseases, \$6,000.

Total, Fruit-Disease Investigations, \$69,395, including \$5,780 statutory.

[Regulation.]

ERADICATION OF CITRUS CANKER.**Eradication of Citrus Canker:**

Object.—To eradicate citrus canker, a very serious disease of oranges, lemons, grapefruit, and other citrus fruits.

Procedure.—Trees in the citrus regions of the Gulf States are inspected for the presence of citrus canker. Affected trees are burned as they stand, using oil spray. The burning is done by State officials under State authority.

Cooperation.—Agreements have been entered into with the States of Florida, Georgia, Alabama, Mississippi, Louisiana, and Texas, whereby the Bureau of Plant Industry pays the salaries of inspectors, also traveling and other necessary expenses. Each State details a director in local charge of the work and pays the salaries of the men engaged in burning infected trees and the expense of other activities involving destruction of property under State laws.

Location.—Headquarters are maintained at Gainesville, Fla., Atlanta, Ga., Auburn, Ala., Agricultural College, Miss., Baton Rouge, La., and Houston, Tex.

Date begun.—1915.

Results.—Much progress has been made in locating the disease in the States mentioned and immediate steps have been taken for the destruction of all trees showing the presence of the disease. The present methods will eradicate the disease, though three years or more may be needed to attain complete success.

Assignment.—K. F. Kellerman.

Proposed expenditures, 1916-17.—\$335,715, including an unexpended balance of \$85,715 under the urgent deficiency act of February 28, 1916.

INVESTIGATIONS IN FOREST PATHOLOGY.

SUPERVISION.

Supervision:

Object.—To care for office and laboratory routine.

Procedure.—Maintenance of notes, records, authorizations, audits, correspondence, files, and general office facilities; maintenance of culture-media supply and laboratory accommodations.

Location.—Washington, D. C.

Date begun.—1907.

Assignment.—Haven Metcalf.

Proposed expenditures, 1916-17.—\$7,287, including \$825 statutory (research, \$4,858; regulation, \$2,429).

[Research.]

DISEASES OF SHADE AND ORNAMENTAL TREES AND SHRUBS.

Diseases of Shade and Ornamental Trees and Shrubs:

Object.—Investigation of these diseases with reference to control.

Procedure.—Studies are made to determine the weak points in the life histories of these diseases, to improve and standardize methods of tree surgery, to determine varietal and specific resistance to disease, and to ascertain the distribution, extent, and annual occurrence of these diseases, with particular reference to their danger as possible epidemics.

Cooperation.—Department of Botany, Brown University, Providence, R. I.

Location.—Providence, R. I.

Date begun.—1907.

Results.—(1) During 1916: About 12,000 letters of information were prepared and sent to correspondents. Two Government patents in tree surgery were prepared for filing.

(2) Prior to 1916: Many demonstrations have been made of the best methods of tree surgery and disease control. Increased public use of the ginkgo and other resistant trees has resulted. About 40,000 inquiries for information along this line have been answered.

Assignment.—Haven Metcalf, J. F. Collins.

Proposed expenditures, 1916-17.—\$2,932, including \$525 statutory.

(Survey of Diseases of Shade and Ornamental Trees and Shrubs: Discontinued as a separate project; included under "Diseases of Shade and Ornamental Trees and Shrubs.")

[Research.]

PATHOLOGICAL PROBLEMS IN WOOD PRESERVATION.

(Decay of Mining Timbers: Discontinued as a separate project; included under "Pathological Problems in Wood Preservation.")

(Pathological Problems of Deterioration of Fire-Killed Timber: Discontinued as a separate project; included under "Pathological Problems in Wood Preservation.")

Pathological Problems in Wood Preservation:

Object.—To work out miscellaneous problems on the pathological aspects of wood preservation.

Procedure.—Studies are made of the specific toxicity of wood preservatives against certain saprophytes; of the cause, conditions, and possible means of control of decay in building timbers under yard and storage conditions, and in mining timbers; of the histology and cytology of wood rot in general; and of the natural resistance of various species of wood to decay.

Cooperation.—Forest Products Laboratory, Forest Service.

Location.—Madison, Wis.

Date begun.—1909.

Results.—(1) During the past year tests of standard and proprietary wood preservatives against pure cultures of wood-destroying fungi have been continued. A method of testing heavy oils has been invented. Studies of conditions surrounding structural timber in storage have been continued, and it has been shown that decay in storage is preventable by slight and perfectly practicable changes in lumber-yard management.

Pathological Problems in Wood Preservation—Continued.

(2) Prior to 1916: Definite knowledge has been obtained of the causes of certain types of decay of mining timbers, of the causes and conditions of various wood rots, and of the specific action of various preservatives. A method has been developed for quickly testing the toxicity of preservatives against pure cultures of wood-destroying fungi (method and tests published in Department Bulletin 227). Practical results are reflected in wood-preservation work of the Forest Products Laboratory.

Assignment.—C. J. Humphrey, Ruth M. Fleming.

Proposed expenditures, 1916-17.—\$4,026, including \$125 statutory.

[Research.]**FOREST-TREE DISEASES.**

(Effects of Sulphur and Other Gases on Forest Trees: Discontinued as a separate project; included under "Miscellaneous Forest-Tree Diseases.")

Diseases of Forest Nursery Stock:

Object.—Investigations of these diseases with reference to control.

Procedure.—This project involves the testing of the effects of various soil fungicides and amendments, of spraying, and of modifications of nursery practice on "damping-off" and other nursery diseases.

Cooperation.—Forest Service and private nurserymen.

Location.—Cass Lake, Minn., East Tawas, Mich., Wasatch National Forest, and many other national and private nurseries in 11 States.

Date begun.—1910.

Results.—"Blight" of coniferous seedlings has been controlled by change in methods of watering; "damping-off" controlled by soil treatment with sulphuric acid, which also stimulates growth of seedlings and keeps down weeds. Weed destruction alone pays for the cost of treatment, leaving disease control a matter of clear profit. Methods and results are contained in a manuscript submitted for publication as a department bulletin. Work has been limited during 1916 to testing in new territory the results of previous years.

Assignment.—Carl Hartley, Roy G. Pierce.

Proposed expenditures, 1916-17.—\$8,567.

(Preliminary Disease Survey of the National and Other Forests: Discontinued as a separate project; included under "Cooperative Field Studies and Demonstrations in Forest Pathology.")

Cooperative Field Studies and Demonstrations in Forest Pathology:

Object.—To determine the best methods of controlling tree diseases, particularly in the national forests.

Procedure.—From detailed and statistical studies of diseased stands in typical areas, rotation and cutting cycles based on disease are established, improved marking and scaling methods developed, and exact cull percentages determined.

Cooperation.—Forest Service.

Location.—Missoula, Mont., Albuquerque, N. Mex., San Francisco, Cal., and generally throughout National Forest Districts 1, 3, and 5, and a few localities in District 6.

Date begun.—1913.

Results.—(1) During 1916: The discovery of a brush-rotting fungus (*Poria* sp.) and studies of its activities have led to the substitution of "pulling" brush for piling it in localities in Arizona, New Mexico, and Arkansas, where it is difficult to pile and burn on account of the shortness of the season during which burning is safe. Preliminary estimates indicate a saving of 27 cents per thousand board feet by this method of brush disposal.

(2) Prior to 1916: The "sanitation clause," which requires the purchaser in Government timber sales to cut all snags and all defective trees marked and to remove and pay for all merchantable lumber contained in such trees, has been developed by the work under this project. The studies also guide planting plans for the future forest in these particular localities.

Assignment.—E. P. Meinecke, Jas. R. Weir, W. H. Long, J. S. Boyce.

Proposed expenditures, 1916-17.—\$11,164.

Miscellaneous Forest-Tree Diseases:

Object.—Investigation, with reference to control, of the nature and life history of various tree diseases and of the effects of smelter fumes upon trees.

Procedure.—The usual methods of investigation of plant diseases are applied to forest-tree diseases.

Cooperation.—Forest Service.

Location.—Washington, D. C., Providence, R. I., Missoula, Mont., Albuquerque, N. Mex., and San Francisco, Cal.

Date begun.—1913.

Results.—Fundamental contributions have been made to the knowledge of about forty diseases, including smelter injury of conifers.

Assignment.—Geo. G. Hedgcock, N. Rex Hunt.

Proposed expenditures, 1916-17.—\$5,384.

Total, Forest-Tree Diseases, \$25,115, including \$1,045 statutory.

IMPORTED AND EPIDEMIC TREE DISEASES.

[Research.]

Miscellaneous Imported and Epidemic Tree Diseases:

Object.—Investigation of the white-pine blister rust, the chestnut bark disease, the pitch-pine blister rust, and other imported and epidemic tree diseases, with reference to their control.

Procedure.—In the course of work under other projects attention is called to these diseases. Their life histories are then studied to find weak points for attack, and their range, origin, and means of spread are determined. Under this project the fundamental problems of spread and adaptation of introduced diseases and the problems of susceptibility of native tree species to foreign diseases are studied.

Cooperation.—Federal Horticultural Board; also informal cooperation with State foresters and private firms and individuals.

Location.—Washington, D. C., Providence, R. I., and various field points in Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, New York, Pennsylvania, New Jersey, Virginia, and other States.

Date begun.—1907.

Results.—(1) During 1916: A chinquapin-Japanese chestnut hybrid resistant to the chestnut bark disease has been developed. Eight newly imported diseases were studied and destroyed by cooperating authorities so far as found.

(2) Prior to 1916: White-pine blister rust has been eliminated wherever found except in localities where legal authority for destruction was lacking. The real nature and origin of the chestnut bark disease and its manner of distribution have been determined. Extensive destruction of advance infections has been accomplished, which may be estimated to have retarded the advance of the disease 15 years. The utilization of disease-killed trees has been made possible. Resistant and immune Asiatic strains have been discovered.

Assignment.—Haven Metcalf, Perley Spaulding, J. Franklin Collins, Ruby J. Tiller.

Proposed expenditures, 1916-17.—\$21,135.

[Regulation.]

Eradication of White-Pine Blister Rust:

Object.—To eradicate or control the white-pine blister rust.

Procedure.—Shipments and reshipments of imported nursery stock of 5-needle pines are located and inspected for the presence of white-pine blister rust. When the disease is found the diseased trees are destroyed by the appropriate State officials; when legally or otherwise possible, the entire shipment is destroyed. Secondary infections on currants or 5-leaf pines are also located and destroyed. Investigations of methods of eradication are conducted particularly with reference to exact and more prompt identification of critical, dormant, immature, and old cases.

Cooperation.—New Hampshire Forestry Commission, Massachusetts State Board of Agriculture, State Forester of Vermont, and Conservation Commission of New York. Formal cooperation with other States is yet to be arranged.

Location.—Wherever the white-pine blister rust occurs or is suspected to be present, particularly throughout the range of the 5-needle pines. This may involve work throughout the United States.

Eradication of White-Pine Blister Rust—Continued.*Date begun.*—March 22, 1916.*Assignment.*—S. B. Detwiler, Perley, Spaulding, Roy G. Pierce, G. F. Gravatt, Minnie W. Taylor, Reginald H. Colley.*Proposed expenditures, 1916-17.*—\$31,927, including an unexpended balance of \$726 under the urgent deficiency act of February 28, 1916.**Total, Imported and Epidemic Tree Diseases, \$53,061, including \$2,000 statutory (research, \$21,135; regulation, \$31,926).****Total, Investigations in Forest Pathology, \$92,421, including \$4,520 statutory (research, \$58,066; regulation, \$34,355).****COTTON, TRUCK, AND FORAGE-CROP DISEASE INVESTIGATIONS.****SUPERVISION.****Supervision:***Object.*—To provide for the administrative, clerical, and routine laboratory work necessary for the proper conduct of the research projects.*Location.*—Washington, D. C.*Date begun.*—1901.*Assignment.*—W. A. Orton, H. A. Edson.*Proposed expenditures, 1916-17.*—\$14,915, including \$9,200 statutory.**COTTON DISEASES.****[Research.]****General Investigation of Cotton Diseases:***Object.*—To study cotton diseases, discover preventive or remedial treatment, and breed resistant varieties, especially early, big-bolled, wilt-resistant varieties adapted to boll-weevil conditions in the eastern part of the cotton belt and long-staple wilt-resistant varieties.*Procedure.*—General pathological work is carried on in the Washington laboratory. Resistance breeding is conducted on plats of infected land rented from farmers. Field observations on disease occurrence are made.*Location.*—Washington, D. C., Florence, S. C., Americus, Ga., and Brundidge and Andalusia, Ala.*Date begun.*—1899.*Results.*—(1) Prior to 1916: Successful methods for breeding wilt-resistant cotton worked out; two satisfactory short-staple, upland types produced and introduced into cultivation; three promising new, early, big-bolled, wilt-resistant strains bred, tested under boll-weevil conditions, and their propagation for distribution begun; progress made in the breeding of long-staple, wilt-resistant, upland types; preliminary work done on the control of cotton root-rot; and the following publications issued: Division of Vegetable Pathology and Physiology Bulletin 27, Farmers' Bulletins 302, 333, 555, and 625, Bureau of Plant Industry Bulletin 105, Part 2, and Bureau of Plant Industry Circulars 9 and 92.

(2) During 1916: Further tests of the most promising new hybrids have shown that they possess the qualities sought, viz, earliness, uniformity, large bolls, good length and percentage of lint, good yielding power, and wilt resistance. Those bred especially for earliness and tested under boll-weevil conditions ranked well in comparison with the earliest resistant cottons, with the added quality of exceptionally large bolls. It has been definitely established that cotton wilt is not transmitted by the seed.

Assignment.—W. A. Orton, W. W. Gilbert, L. O. Watson.*Proposed expenditures, 1916-17.*—\$2,578.**[Extension.]****Cooperative Wilt-Resistant Cotton and Cowpea Breeding:***Object.*—To instruct farmers in methods of breeding wilt-resistant cotton and cowpeas, stimulate production of resistant seed, and demonstrate methods for control of root-knot; also to maintain a connection between the bureau investigations and the department and State extension workers.*Procedure.*—The project leader works with a collaborator in each State to train plant breeders, guide them in their methods, and stimulate the production of pure strains of the resistant varieties originated by the department. Demon-

Cooperative Wilt-Resistant Cotton and Cowpea Breeding—Continued.

strations are carried out through county and local agents, whom the project leader instructs in plant-disease control through personal visits and attendance at meetings. The county and local agents pass the information on to the farmers. It is proposed to appoint a pathological adviser, who will keep in close touch with the State and county agents, assisting the farmers through them in the better understanding of the control of cotton diseases by the application of the methods already worked out.

Cooperation.—South Carolina and Alabama experiment stations.

Location.—Florence, S. C., Auburn, Ala., and other points in these States.

Date begun.—1911.

Results.—(1) Prior to 1916: The work in Georgia has been fully organized and turned over to the State. The South Carolina work is well organized and a large number of cooperative breeders have been instructed in methods for producing wilt-resistant cotton and wilt and root-knot resistant cowpeas. These cooperators grow each year, under the supervision of this department, considerable quantities of seed for sale to other farmers. A good beginning was made in Alabama along the same lines. Extension workers were instructed in our methods and assisted from time to time.

(2) Excellent progress was made during the past season in South Carolina and Alabama, and this work has proven of great value to the farmers. The quantity and quality of the seed produced the past year exceeded that of any previous year, and the interest manifested in this work was also greater than ever before. The acreage will be increased the present season. The Dixie variety has grown so much in popularity that many farmers prefer it for land free from disease. Greater financial saving than in any previous year has been brought about through the use of the wilt-resistant cotton. The demand for seed is still in excess of the supply.

Assignment.—L. O. Watson, H. B. Tisdale, J. Lewis Seal.

Proposed expenditures, 1916-17.—\$4,570.

Total, Cotton Diseases, \$7,148 (research, \$2,578; extension, \$4,570).

[Research.]

TRUCK-CROP DISEASES.**Potato Diseases:**

Object.—To discover causes and methods of prevention or control of the more important potato diseases, particularly those involved in the interstate seed industry and those presenting difficult problems requiring long-continued investigations, collaboration of several specialists, and experimentation in different States; also those relating to Federal quarantines.

Procedure.—The general pathological studies are carried on in the Washington laboratories in winter and at the field stations in summer. All the work is closely correlated with the potato investigations of the Office of Horticultural and Pomological Investigations, being located at the same field stations in Maine, Colorado, and Idaho. The disease resistance of their new varieties is tested by inoculations in the Washington greenhouses as well as in the field, and cytological studies are made to determine the nature of disease resistance. The potato diseases transmitted by seed tubers are studied, and healthy strains produced in the North are tested in the South and West. In general, the investigations are of an exhaustive or monographic character and are carried out from a national viewpoint. Results of local applications are made available to the States for extension purposes. The Colorado and Idaho studies are closely interrelated. The Office of Plant Physiological and Fermentation Investigations in this bureau cooperates in the study of tuber rots, particularly the western "leak," and the Office of Soil-Fertility Investigations is cooperating in a study of the relation of soil conditions to powdery scab and other diseases.

Cooperation.—The experiment stations of Idaho, Maine, and Colorado, the College of Agriculture at Cornell University, and the Board of County Commissioners of Weld County, Colo.; informal cooperation with other States and with farmers.

Location.—Presque Isle and Caribou, Me., Jerome, Idaho, Greeley, Colo., Norfolk, Va., the Stockton district of California, and other points.

Date begun.—1908.

Results.—(1) Prior to 1916: Field stations have been established in Idaho, Colorado, and Maine. Studies of potato late-blight have shown that the disease winters over in the tubers and that field epidemics arise from planting diseased

Potato Diseases—Continued.

seed. A method for testing the resistance of varieties to this disease was worked out. Several new diseases, including leaf-roll, curly-dwarf, mosaic, streak, etc., were found to be the cause of serious losses, which are largely preventable through seed selection. Field methods for the production of disease-free potatoes were demonstrated practicable; the causes of tuber rots in storage determined and control through careful handling and cool storage indicated; progress made in the study of the life history and distribution of powdery scab. The following publications were issued: Bureau of Plant Industry Bulletin 245, Farmers' Bulletins 544 and 489, Bureau of Plant Industry Circulars 23 and 52, a separate entitled "Silver Scurf, a Disease of the Potato," in Bureau of Plant Industry Circular 127, and Department Bulletins 47, 64, 81, and 82.

(2) During the fiscal year 1916 the laboratories at Presque Isle and Greeley were fully equipped. Progress was made in studies to determine the nature of leaf-roll, and a cooperative agreement with the College of Agriculture at Cornell University made to further the study of this and related diseases. Experiments have shown that the organisms causing potato wilt, common scab, Rhizoctonia, black rot, and jelly end-rot are present in the raw desert lands in Idaho and that before a healthy crop of potatoes can be grown on such lands they must be planted for some years to alfalfa or grain crops. Monographic studies of the genus *Phytophthora* were nearly completed. Further studies on the life history of powdery scab have been completed and results published. Observations and experiments with this disease indicate that the more serious developments of this trouble may be confined to cool, poorly drained soils. Further experiments with potato "leak" have established the facts that the cause is a soil fungus and that losses from this disease can be avoided by greater care in digging and sorting out all wounded potatoes in the field. Data published in the *Journal of Agricultural Research*, vol. 4, No. 3, vol. 5, No. 2, and vol. 5, No. 5; also in Wisconsin Experiment Station Bulletin 37, "Germination and Infection with the Fungus of the Late Blight of Potato."

Assignment.—H. A. Edson, L. O. Kunkel, J. Rosenbaum, M. Shapovalov, H. G. MacMillan, O. A. Pratt, W. B. Clark, C. W. Carpenter, G. L. Zundel, L. A. Hawkins, E. S. Schultz, Ernst Artschwager.

Proposed expenditures, 1916-17.—\$22,673.

Potato-Seed Inspection and Certification:

Object.—To provide means for improving the quality of potato stock, particularly that entering into interstate trade, with reference to freedom from disease, trueness to type, and freedom from varietal mixtures; and to assist the States in bringing about its successful establishment.

Procedure.—A plan for inspection and certification of seed potatoes was inaugurated and has been adopted by most of the northern potato-growing States. The Bureau of Plant Industry does not issue any certificates but cooperates with State officials by furnishing advice and information gained through its potato-disease and varietal investigations.

Cooperation.—Informal cooperation with experiment stations and departments of agriculture or horticulture in the several potato-growing States.

Location.—Washington, D. C., and all principal potato States.

Date begun.—1914.

Results.—(1) Prior to 1916: The plan for potato-seed inspection and certification adopted and put into practice in Wisconsin, Maine, Michigan, and Minnesota; a considerable quantity of seed certified, much of it being retained in the States for use the following year; uniform standards for seed potatoes formulated.

(2) During 1916: This movement has steadily gained ground and is now being put into practice in seven States, including New York, Vermont, and California in addition to those previously mentioned. The need for a more definite guarantee of the fitness of potatoes for seed purposes has been more fully recognized. Much benefit to the potato industry has resulted from the production of better seed and increased interest in disease control and marketing problems. The indications are that within a few years every important northern State will have adopted the certification plan, and it is even possible that some southern States will require certificates with the seed they buy. A department bulletin dealing fully with this subject is in preparation and will be published soon.

Assignment.—W. A. Orton, William Stuart.

Proposed expenditures, 1916-17.—\$492.

Sweet-Potato Diseases:

Object.—To study the several sweet-potato diseases and discover means of control.

Procedure.—Thorough pathological studies are made in the Washington laboratory, including inoculation experiments and tests in greenhouses and gardens. Field trials of control methods in farmers' hotbeds and fields are made, and general surveys of the country are conducted to discover the occurrence and prevalence of the diseases. The work in the East is being transferred to the extension forces as its several phases are completed. Diseases of the Southern and Central States are now receiving more attention, and work is being done on the control of troubles connected with storage conditions.

Cooperation.—Virginia Truck Experiment Station; informal cooperation with farmers in New Jersey and Virginia.

Location.—Washington, D. C., Vineland, N. J., and Norfolk and Tasley, Va.

Date begun.—1911.

Results.—(1) Prior to 1916: The dry-rot, foot-rot, and stem-rot diseases of sweet potatoes were investigated and the results published. Successful control measures for stem-rot and black-rot were worked out and demonstrated. Investigations of the resistance of different varieties to stem-rot were completed and rotation experiments begun. The following papers were published: "The Stem-Rot of the Sweet Potato," *Phytopathology*, vol. 4, No. 4; "The Foot-Rot of the Sweet Potato," *Journal of Agricultural Research*, vol. 1, No. 3; "Notes on the Distribution and Prevalence of Three Important Sweet-Potato Diseases," *Phytopathology*, vol. 5, No. 2; "Experiments on the Susceptibility of Sweet-Potato Varieties to Stem-Rot," *Phytopathology*, vol. 5, No. 3.

(2) During 1916: Investigations of sweet-potato scurf were completed and the results published in the *Journal of Agricultural Research*, vol. 5, No. 17; also a method of control discovered and put into practice. A disease survey was made of the sweet-potato growing area of the Southern, Middle Western, Central, and Southwestern States. Black-rot was found widely distributed; stem-rot prevalent in Illinois, Iowa, Kansas; foot-rot in Virginia, Iowa, and Illinois; root-rot in Texas. Storage rots were also found generally prevalent and constitute one of the chief barriers to the extension of the industry. Experiments for their control have been begun. Successful demonstrations of methods for the control of foot-rot were made. Farmers' Bulletin 714, "Sweet Potato Diseases," has been published.

Assignment.—L. L. Harter, C. W. Carpenter, J. A. McClintock.

Proposed expenditures, 1916-17.—\$5,785.

Malnutrition of Truck Crops:

Object.—To determine the causes and means of control of diseases of truck crops associated with abnormal soil conditions, excessive use of fertilizers, continuous cropping, etc.

Procedure.—Laboratory studies of diseased material conducted in cooperation with the Office of Plant Physiological and Fermentation Investigations; field tests with fertilizers, soil treatment, green manures, etc., made.

Cooperation.—Virginia Truck Experiment Station.

Location.—Washington, D. C., and Norfolk, Va.

Date begun.—1906.

Results.—(1) Prior to 1916: This trouble has been found controllable by liming the soils and filling them with humus. Since the publication of these results in Bulletins 1 and 4 of the Virginia Truck Experiment Station, the disease has largely disappeared, except on spinach.

(2) During 1916: The work during the past year has been confined to a study of spinach malnutrition and experiments for its control. Progress has been made, but the problem is not yet solved.

Assignment.—L. L. Harter, J. A. McClintock.

Proposed expenditures, 1916-17.—\$640.

Breeding Rust-Resistant Asparagus:

Object.—To secure improved strains of asparagus immune to rust.

Procedure.—All obtainable varieties of asparagus were subjected to field infection and from one, Reading Giant, resistant individuals were selected and crossed, their progeny compared, and the most desirable breeding stock isolated. The search continues for still better strains. Seedlings are grown and distributed. The work is now extended to South Carolina, and the project will be continued until resistant varieties are fully established in commercial culture.

Cooperation.—Massachusetts Experiment Station and Massachusetts Asparagus Growers' Association.

Breeding Rust-Resistant Asparagus—Continued.

Location.—Washington, D. C., Concord, Mass., and Hartsville and Monetta, S. C.

Date begun.—1906.

Results.—(1) Prior to 1916: Rust-resistant strains of better quality than any commercial varieties were produced, the new method of breeding being also applicable to improvement in quality and yield. The testing and production of these varieties by growers in different localities was begun, and Bureau of Plant Industry Bulletin 263 published.

(2) During 1916: Further selection of high-quality resistant strains has been made and highly satisfactory results secured from trials. About 8,000 roots of resistant plants and 30 pounds of selected seed were distributed. It is expected that this asparagus will eventually replace all commercial varieties now in cultivation.

Assignment.—J. B. Norton.

Proposed expenditures, 1916-17.—\$3,320.

Cucumber Diseases:

Object.—To study diseases of cucumbers, especially those causing recent losses in the pickle-growing sections; to develop and test methods for their control, breed disease-resistant varieties, and determine the effect of fungicides on the setting of cucumber fruits.

Procedure.—The pathological studies are divided among department and State investigators and are conducted in Washington and at field stations in three States. Spraying, varietal, and fertilizer tests and crop-rotation experiments are also conducted at these stations, which are located in States where the heaviest losses have occurred.

Cooperation.—Experiment stations of Indiana, Wisconsin, and Michigan, and the H. J. Heinz Co., of Pittsburgh, Pa.

Location.—Washington, D. C., Plymouth, Ind., Madison, Wis., and Big Rapids, Mich.

Date begun.—1915.

Results.—Valuable data accumulated regarding the best fertilizers, varieties, and date and distance of planting, in their relation to disease occurrence; a fairly complete survey made of cucumber-disease occurrence in Wisconsin, Indiana, and Michigan, and information secured as to the nature and extent of the various diseases; studies of the organisms causing cucumber scab, anthracnose, and angular leaf-spot begun; "white pickle" discovered to be a mosaic disease, its mode of dissemination determined, and methods of control indicated. Considerable data have been accumulated regarding the best fungicides for disease control and the effect of spraying on the yield of cucumbers. A preliminary report on the cucumber mosaic disease has been published in *Phytopathology*, vol. 6, No. 2.

Assignment.—W. W. Gilbert, M. W. Gardner, G. A. Osner, Harry Braun.

Proposed expenditures, 1916-17.—\$4,750.

Cabbage Diseases:

Object.—To produce varieties of cabbage resistant to the *Fusarium*-wilt disease, adapted to the various cabbage-growing sections, and of suitable quality for commercial use, thus extending to other States the work successfully begun by the Wisconsin Experiment Station.

Procedure.—A preliminary survey of all the important cabbage-growing districts was first made, to determine the prevalence of the *Fusarium* wilt disease and the requirements of the industry. The Wisconsin wilt-resistant strains and suitable commercial varieties are tested on infected land at the experiment stations in the States interested and selections made from those showing any resistance. Seed of the best of these is grown in Florida during the winter for planting the following season.

Cooperation.—Wisconsin, Delaware, Iowa, and Ohio experiment stations.

Location.—Newark, Del., Wooster, Ohio, Nichols, Iowa, and Brooksville, Fla.

Date begun.—1915.

Results.—During the past year cooperative arrangements were made with the experiment stations in Wisconsin, Delaware, Iowa, and Ohio for the conduct of the work. The Wisconsin strains showed a fair degree of resistance to wilt in all the tests but are not adapted to the needs of all sections. Several of the commercial varieties tested gave promising results. A good beginning has been made, but much further breeding and selecting will be necessary.

Assignment.—L. L. Harter, J. B. Norton.

Proposed expenditures, 1916-17.—\$870.

(**Monograph of Fusarium:** Project suspended. The compiling of a synonymy of the genus *Fusarium* has been completed and the results prepared for publication.)

Nematode Diseases of Truck Crops:

Object.—The investigation of diseases of truck crops and related plants caused by parasitic nematodes and the discovery and application of remedial measures.

Procedure.—Laboratory and greenhouse studies of parasitic eelworms, their life history and method of attack, are made in Washington. Field experiments with control measures, especially crop rotations, are under way. In cooperation with the Office of Foreign Seed and Plant Introduction, efforts are being made to free the department propagating gardens in Florida and Maryland from root-knot. The work is being extended as opportunity permits to lessen the enormous losses now caused in the South and Southeast by these parasites.

Cooperation.—South Carolina Experiment Station.

Location.—Washington, D. C., Yarrow, Md., Florence, S. C., Brooksville, Fla., and other points.

Date begun.—1914.

Results.—(1) Prior to 1916: The general outlines of farm methods of control were determined; special results obtained with dasheens through the application of hot water and cyanide fumigation; and Farmers' Bulletin 648, "The Control of Root-Knot," published.

(2) During 1916: Laboratory studies of the various parasitic nematodes have yielded valuable data. Rotation experiments are in progress. Tests of varieties for resistance to root-knot indicate the possibility of developing a strain of cotton highly resistant to this disease. Selections made last season for resistance were tested and gave excellent results. Further trial of the hot-water treatment for the control of root-knot of dasheens gave results confirming those of last season and indicate the practicability of applying the method on a large scale. This treatment is also being tested for freeing nursery stock from infection.

Assignment.—L. P. Byars.

Proposed expenditures, 1916-17.—\$3,000.

Miscellaneous Truck-Crop Diseases:

Object.—To determine the cause of truck-crop diseases and find methods for suppression and control.

Procedure.—This project includes the necessary work done on lesser problems and on suspended or nearly closed projects and the identification of material received at Washington from correspondents. It involves mainly laboratory work in Washington, with some field trips to meet emergency calls.

Location.—Washington, D. C.

Cooperation.—State experiment stations.

Date begun.—1901.

Results.—(1) Prior to 1916: Numerous diseases identified and correspondents advised regarding treatment; a new tomato fruit rot caused by *Phoma destructiva* worked out and published; two wilt diseases of okra differentiated and causes determined; cooperation with State stations on tomato diseases secured; the causes and methods of control determined for all of the most important ginseng diseases, and the life histories of the parasites studied; results published in Bureau of Plant Industry Bulletin 250. Other publications on miscellaneous truck-crop diseases are: "Phoma Destructiva, the Cause of a Fruit Rot of the Tomato," Journal of Agricultural Research, vol. 4, No. 1, and "Foot-Rot, Leaf-Spot, and Stem-Blight of the Eggplant," Journal of Agricultural Research, vol. 2, No. 5.

(2) During 1916: Tests of tomato varieties for resistance to the *Fusarium*-wilt disease gave several satisfactory commercial strains which show a fairly high degree of resistance. The best of these are being propagated for distribution and further tests next year. Work on breeding tomatoes resistant to the bacterial wilt and the *Septoria* leaf-spot was begun. A stem-end decay of watermelons has been investigated, the cause determined, and the results prepared for publication. A large number of specimens of diseased material have been received and examined and the parasites identified. The following publications have been issued: "Some Ginseng Troubles," Michigan Agricultural College Special Bulletin 72; "Experiments on the Control of the Root-Knot Nematode," Michigan Agricultural College Technical Bulletin 20; "Phytophthora Disease of Ginseng," Cornell Station Bulletin 363; "Pathogenicity and Identity of

Miscellaneous Truck-Crop Diseases—Continued.

Sclerotinia Diseases on Ginseng" and "Alternaria Panax, Causing a Root-Rot of Ginseng," Journal of Agricultural Research, vol. 5, No. 7, and vol. 5, No. 4; "Ginseng Diseases and Their Control," Farmers' Bulletin 736, and a paper entitled "The Storage Rots of Dasheens," Journal of Agricultural Research, vol. 6, No. 15.

Assignment.—W. A. Orton, H. A. Edson, F. J. Pritchard, L. L. Harter, W. W. Gilbert, J. B. Norton, C. W. Carpenter, L. O. Kunkel, L. P. Byars, F. C. Meier, H. G. MacMillan, Michael Shapovalov, Joseph Rosenbaum, O. A. Pratt.

Proposed expenditures, 1916-17.—\$3,942.

Total, Truck-Crop Diseases, \$45,472, including \$720 statutory.

[Research.]

FORAGE-CROP DISEASES.**Forage-Crop Diseases:**

Object.—To study diseases of forage crops, especially alfalfa, clover, and cowpeas, work out control measures, and breed resistant varieties.

Procedure.—Laboratory studies are conducted in Washington and at Madison, Wis. Disease-resistant cowpea breeding is conducted in field plots and the general conditions governing disease resistance in other legumes studied. The relation of fungi to clover sickness has been taken up, and other activities are pending, awaiting larger support.

Location.—Washington, D. C., Madison, Wis., and other points.

Date begun.—1900.

Results.—(1) Prior to 1916: Laboratory studies on material received from various sources made and a number of diseases identified; causes and control measures for many diseases of cowpeas determined and wilt-resistant varieties produced; notes collected on the distribution of alfalfa diseases and a mimeographed circular on "Crown Wart of Alfalfa" prepared.

(2) During 1916: The wilt and root-knot resistant cowpeas have been introduced into general cultivation on infected land and their value in the control of these diseases demonstrated. Numerous miscellaneous specimens have been examined and field observations on disease occurrence made. Cooperative arrangements have been made with the Wisconsin Experiment Station for active work on clover and alfalfa diseases during the present season.

Assignment.—L. L. Harter, L. O. Watson, F. J. Pritchard, F. R. Jones.

Proposed expenditures, 1916-17.—\$1,385.

[Extension.]

EXTENSION WORK IN THE CONTROL OF COTTON, TRUCK, AND FORAGE-CROP DISEASES.**Extension Work in the Control of Cotton, Truck, and Forage-Crop Diseases:**

Object.—To demonstrate methods of control of cotton, truck, and forage-crop diseases and to secure their general adoption by farmers; and to assist the county agents and other extension workers in the solution of their cotton, truck, and forage-crop disease problems, through a closer connection with the correlated research activities of the Federal and State pathological officers.

Procedure.—In carrying on demonstration work under the projects which will be formulated under this general title, the leaders of the various lines of work, either in person or through associated plant pathologists, will meet and assist county agents and other extension workers in adopting plans suited to local conditions and in acquainting them thoroughly with the subject matter to be demonstrated. It is understood that the county agents will then be solicited to undertake the general dissemination of these plans. It is understood that they will also select a number of farmers who will agree to conduct specific demonstrations of the methods of disease control on their farms. The demonstrations will be repeated and extended during the second year and thereafter until the methods are well known by the farmers. In case new phases of the problems selected develop, they will be brought to the attention of the State and Federal pathologists for the working out of control measures.

Cooperation.—Through States Relations Service, with extension divisions of State agricultural colleges; various State organizations, and private growers.

Extension Work in the Control of Cotton, Truck, and Forage-Crop Diseases—Continued.

Location.—North Carolina, Alabama, Georgia, Florida, and New Jersey; will be extended to other States later.

Date begun.—1916.

Assignment.—L. O. Watson.

Proposed expenditures, 1916-17.—Cost of work included under research projects.

Total, Cotton, Truck, and Forage-Crop Disease Investigations, \$68,920, including \$9,920 statutory (research, \$64,350; extension, \$4,570).

[Research.]

CROP PHYSIOLOGY AND BREEDING INVESTIGATIONS.**Supervision:**

Object.—This project covers the general office work necessary in connection with the scientific investigations of the office.

Location.—Washington, D. C.

Date begun.—1906.

Assignment.—Walter T. Swingle.

Proposed expenditures, 1916-17.—\$5,610.

Testing Farms on Indian Reservations:

Object.—To test crops likely to prove suitable for culture by the Indians and at the same time to train the latter in the methods of handling crops apt to be grown, with the help of Indian labor, by white settlers in the regions near the reservations.

Procedure.—Preliminary trials are made, in cooperation with other offices of the Bureau of Plant Industry, of garden and field crops, and then a careful study made of those which promise to be of most value to the Indians. Attention is also given to the training of Indians in the handling of various crop plants, to determine the best methods for the utilization of Indian labor.

Cooperation.—Office of Indian Affairs, Department of the Interior.

Location.—Principal testing station at Sacaton, Ariz.; minor stations at Shiprock, N. Mex., Palm Springs, Cal., and Pyramid Lake, Nev.

Date begun.—1907.

Results.—From a small initial planting of Egyptian cotton when the work was inaugurated in 1912, the industry has grown with surprising rapidity, due largely to the work at Sacaton, Ariz. The crop marketed the past season brought nearly \$500,000. A new type of Egyptian cotton, with the longest and best fiber of any cotton of this type in the world, has been produced as a result of the breeding work at Sacaton and is now being introduced into commercial culture. Unquestionably the most important achievement in connection with the work under this project has been the introduction of the commercial culture of Egyptian cotton into Arizona. It has already been demonstrated that Egyptian cotton of the finest quality can be produced in this country, and large commercial plantings are being made, especially in the Salt River Valley of Arizona.

In addition to Egyptian cotton, many field and garden crops have been introduced into culture among the Indians, including Bermuda onions, dates, figs, pistaches, grapes, pears, pecans, corn, alfalfa, sorghum, etc. The most important of these so far are the Bermuda onion, Sacaton corn (a high-yielding variety adapted to Arizona conditions), and Peruvian alfalfa, which, on account of its ability to grow during cool weather, gives two more cuttings a year in the Southwest than ordinary alfalfa and is rapidly being adopted by both Indians and white settlers.

Different phases of the Egyptian cotton work have been described in Bureau of Plant Industry Bulletins 128, 156, 200, 249, Department Bulletins 38, 311, and 332, Farmers' Bulletin 577, and several informal circulars and documents issued by the department.

Assignment.—Walter T. Swingle, S. C. Mason, E. W. Hudson, S. H. Hastings, the latter being superintendent of the Sacaton station.

Proposed expenditures, 1916-17.—\$11,283.

Date Culture and Breeding:

Object.—To establish date culture on a commercial scale in the United States and, by breeding, to develop new varieties better suited to American conditions than any of the imported sorts.

Procedure.—A careful study was made of the soil, climatic, and cultural requirements of the date palm to determine the locations in this country in which the industry was most likely to prove successful. Offshoots of the best commercial varieties were then introduced from the Old World deserts and tested in date gardens established at selected points in the Southwest. Besides the study of these palms, experiments are also being conducted at the Government date gardens to develop methods for the rapid propagation of date offshoots, the artificial ripening of fruit in unfavorable seasons, and the accurate identification of varieties.

Cooperation.—University of Arizona at Tempe and Phoenix, Ariz., University of California at Mecca, Cal., and private growers in Arizona, California, and Texas.

Location.—Government Date Garden, Indio, Cal., cooperative date gardens at Tempe and Phoenix, Ariz., Mecca and El Centro, Cal., and Laredo, Tex., and private growers in Arizona, California, and Texas.

Date begun.—Preliminary study in 1898; active work under this project inaugurated in 1904.

Results.—During the past year the methods for the artificial ripening of dates have been perfected and systematized so that they can now be applied economically and without difficulty by date growers. The experiments in rapid propagation have shown that offshoots may be forced into a rapid and healthy growth by putting canvas "cold frames" (wooden frameworks covered with canvas) over the offshoots in the field.

When work under this project was inaugurated, no dates had been produced commercially in this country. Now the date palm is the basis of one of the promising fruit industries of the Southwest, representing an annual investment by private growers of probably \$125,000. Some of the palms are now bearing fruit, which is finding a ready market at good prices. These American-grown dates are equal and in some cases even superior to the finest varieties produced in the Old World. Methods have been worked out for the accurate identification of varieties by their leaf characters, thus helping to prevent substitution in importations.

Date culture in general, with particular reference to the introduction and extension of the industry in America, has been discussed in the Department Yearbook for 1900, Bureau of Plant Industry Bulletins 53, 54, and 92, Department Bulletins 223 and 271, Bureau of Plant Industry Circular 129, and a number of informal circulars.

Assignment.—Walter T. Swingle, Silas C. Mason; Bruce Drummond, foreman of the Government Date Garden at Indio, Cal.

Proposed expenditures, 1916-17.—\$14,782.

Caprification of the Fig and Breeding New Varieties of Figs and Caprifigs:

Object.—To discover economical and practical methods for the caprification of Smyrna figs, in order to establish their culture on a commercial scale in this country; to breed new types of figs better suited to American conditions than varieties imported from abroad; and to make an incidental study of the possibilities for caprifying figs of the non-Smyrna type.

Procedure.—As large an assortment as possible of caprifigs adapted to American conditions will be secured, in order that the fig insect (*Blastophaga*) may be permanently naturalized. New types of figs will be developed by breeding, and growers will be assisted by distributing free, until their own caprifig trees become established, the caprifigs necessary for fertilizing their Smyrna figs. Any new and promising varieties originated by the department are distributed to growers free.

Cooperation.—Private growers.

Location.—Loomis and other points in California.

Date begun.—Preliminary studies, in 1898; active work under this project inaugurated in 1904.

Results.—As a result of the encouragement given the fig growers of California by the department, the Smyrna fig industry is rapidly spreading, and during the past year approximately 6,000 tons of figs were produced in the State, about one-third being of the drying type.

Caprification of the Fig and Breeding New Varieties of Figs and Capri-figs—Continued.

Prior to the inauguration of work under this project, no figs of the Smyrna type had been grown in this country, though repeated attempts had been made to introduce them into culture. Preliminary studies revealed the fact that an insect (*Blastophaga*) was absolutely essential for the proper fertilization of figs of the Smyrna type. The first year after the insect was brought to California a few figs were produced, and the production has increased until the present annual value of the fig crop in California is estimated to be \$150,000 or more.

The introduction of the fig insect is described in a technical paper submitted to Science in 1899 and in the Department Yearbook for 1900. General phases of the work on the introduction of Smyrna fig culture have been discussed in Bureau of Plant Industry Circular 537 and in miscellaneous papers contributed to the reports of fruit growers' conventions of California.

Assignment.—Walter T. Swingle, G. P. Rixford.

Proposed expenditures, 1916-17.—\$4,891.

Breeding of Citrus Fruits:

Object.—To develop by breeding new hardy and disease-resistant types of citrus fruits.

Procedure.—An attempt is being made to secure and test all kinds of citrus fruits, wild and cultivated, to determine their value for general culture, for stocks, and for breeding purposes. Various types of citrus are hybridized in an attempt to secure such qualities as hardiness, disease resistance, winter dormancy, etc., and the hybrids resulting are propagated and distributed as rapidly as possible for testing.

Cooperation.—State experiment stations and private growers in the States mentioned under "Location."

Location.—Citrus testing stations at Glen St. Mary, Little River, and Eustis, Fla., and Chico and Riverside, Cal.; minor experiments with State experiment stations and private growers in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Oregon, Texas, and Washington.

Date begun.—1897, when the first hybrids were made; work temporarily suspended and active experiments under the project not inaugurated until 1907.

Results.—The most important results of the past year were the discovery of the comparative canker-resistance of the Japanese and other Asiatic pummelos and the working out of a method for the satisfactory long-distance shipment of pollen by which it was possible to make hybrids between these pummelos and the Florida grapefruit in the hope of breeding a disease-resistant hybrid having the quality of the grapefruit and the canker resistance of the pummelo.

The work under this project has resulted in the origination of the tangelo, a promising new orange, which is being introduced into commercial culture; the citranges, hardy substitutes for the lemon, suitable as dooryard fruits in regions just outside the limits of ordinary orange and lemon culture; and hundreds of new types of citrus fruits, which are now being tested to determine their value for home use or in commercial culture.

Besides the papers contributed to fruit growers' conventions, particularly in Florida, during the past 20 years, the citrus-breeding work has been discussed in the following publications of the department: Bulletin 8 of the Division of Vegetable Pathology and Physiology; articles in Department Yearbooks for 1897, 1904, 1905, and 1906; papers in the Journal of Agricultural Research, vol. 1, No. 1, vol. 1, No. 5, and vol. 2, No. 1; and numerous papers contributed to the Journal of the Washington Academy of Science, etc.

Assignment.—Walter T. Swingle, Maude Swingle, E. M. Savage.

Proposed expenditures, 1916-17.—\$17,399.

Dry-Land Arboriculture:

Object.—To find deep-rooted and drought-resistant tree crops better suited for culture in dry-land regions of the United States than the shallow-rooted annual crops now grown.

Procedure.—These investigations include laboratory and field tests to determine the relative drought resistance and physiological requirements limiting the practical utilization of tree crops in dry-land regions.

Cooperation.—Private growers.

Location.—Sacaton, Ariz., Indio, Cal., Lampasas and San Antonio, Tex., and Fallon and Pyramid Lake, Nev.

Date begun.—1906.

Results.—Experiments were continued during the past year in testing the value of certain wild species of *Prunus* as stocks for cultivated varieties of stone fruits, with the idea of better fitting the latter for culture in dry regions.

Dry-Land Arboriculture—Continued.

Previous investigations under the project revealed a number of American species of *Prunus* promising for use as stocks for commonly cultivated varieties of stone fruits, and one at least, the "wild peach" of Texas, is of excellent quality and valuable in its present form.

Dry-land olive culture is being given a careful test at Sacaton, Ariz., where a special tract has been set aside as a dry-land olive orchard, and various types of olives from the Old World orchards are being tested. Preliminary investigations on wild relatives of cultivated stone fruits were reported on in the *Journal of Agricultural Research*, vol. 1, No. 2. Dry-land olive culture in the United States is discussed in *Bureau of Plant Industry Bulletin* 192.

Assignment.—Silas C. Mason.

Proposed expenditures, 1916-17.—\$2,810.

Establishment of Pistache Culture:

Object.—To introduce pistache culture and establish it on a commercial basis in this country.

Procedure.—A study is made of the life history of the pistache and its wild relatives for the purpose of ascertaining the soil, climatic, and cultural conditions limiting the successful commercial culture of the pistache. Stocks which give the most promise of succeeding under American conditions have been imported and distributed to growers, and these stocks will later be budded to the best commercial pistache varieties.

Cooperation.—Private growers.

Location.—Arizona, California, New Mexico, Texas, Nevada, and Utah.

Date begun.—Preliminary studies abroad in 1899; active work under this project inaugurated in 1904.

Results.—The pistache has been found to succeed admirably in the granite soils of the Sierra foothills almost the entire length of the State of California. Some trees are already in bearing, producing nuts of excellent quality, and it will be only a short time before thousands of the trees already distributed by the department will be producing nuts. Thousands of pistache stocks have been distributed to growers in Arizona, California, New Mexico, Texas, Nevada, and Utah, and as rapidly as these reach the proper size for budding growers are furnished with scions of the best commercial varieties for grafting these stocks. Quite a number of trees in Arizona and California are now bearing, and the nuts are finding ready sale. Train boys in California find that the pistache nuts are preferred to almonds by travelers generally.

The culture of the pistache is discussed in a special circular issued by this office. Investigations along the miscellaneous lines included in this project have been discussed in *Farmers' Bulletin* 250, *Bureau of Plant Industry Bulletin* 81, and miscellaneous papers in *Journal of Mycology, Science, Journal of the Washington Academy of Science*, etc.

Assignment.—Walter T. Swingle, Maude Swingle, G. P. Rixford.

Proposed expenditures, 1916-17.—\$2,065.

Total, Crop Physiology and Breeding Investigations, \$58,840, including \$9,300 statutory.

[Research.]

SOIL-BACTERIOLOGY INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To carry on administrative, clerical, and routine laboratory work necessary for the proper conduct of the research projects.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—K. F. Kellerman.

Proposed expenditures, 1916-17.—\$9,600, including \$5,600 statutory.

DISTRIBUTION AND STUDY OF LEGUME BACTERIA.**Demonstration of Inoculation of Legumes:**

Object.—To demonstrate the benefit of inoculation of legumes with nitrogen-fixing bacteria by careful field experiments personally supervised.

Procedure.—Field experiments are carried on in cooperation with selected farmers in different regions of the United States, and the effect of different methods of preparing and distributing cultures, as well as different methods of inoculating and cultivating the legume crops, are tested on these farms.

Demonstration of Inoculation of Legumes—Continued.

Cooperation.—Selected farmers.

Location.—Georgia, Oklahoma, Pennsylvania, and Virginia.

Date begun.—1901.

Results.—Information is developed which leads to occasional improvement in methods for distributing cultures and for inoculating legumes.

Assignment.—K. F. Kellerman, F. L. Goll, L. T. Leonard.

Proposed expenditures, 1916-17.—\$3,400.

Distribution of Cultures for Inoculating Legumes:

Object.—To distribute pure cultures of nitrogen-fixing bacteria for general field tests in the inoculation of legumes, and to secure reports of results of inoculation from many farmers throughout the various regions of the United States, in order to have data for comparing the effectiveness of commercial cultures used in similar regions.

Procedure.—Upon request, liquid pure cultures of nitrogen-fixing bacteria are forwarded by mail to planters, who report on the success of the treatment after the crop is harvested.

Location.—Throughout the United States.

Date begun.—1901.

Results.—The pure-culture method has proved to be equal in efficiency to inoculation by the use of old field soil, and the quantity and quality of legume crops have been increased and improved throughout the United States.

Assignment.—K. F. Kellerman, L. T. Leonard.

Proposed expenditures, 1916-17.—\$5,720.

Inspection of Commercial Cultures:

Object.—To determine whether commercial cultures sold for inoculating legumes are impure, nonviable, or misbranded.

Procedure.—Commercial cultures are purchased in the open market and tested in the laboratory, in the greenhouse, and in the field.

Location.—Washington, D. C.

Date begun.—1915.

Results.—It is found that the quality of cultures now in the market is very satisfactory.

Assignment.—K. F. Kellerman, L. T. Leonard, F. L. Goll.

Proposed expenditures, 1916-17.—\$3,000.

Laboratory Investigation of Legume Bacteria:

Object.—To investigate the physiology and life history of strains of *Bacillus radicola* and to determine the cross-inoculation of different legume bacteria.

Procedure.—Laboratory and greenhouse studies of methods for stimulating and maintaining the activity of legume bacteria are conducted, as well as studies to determine the varieties which are susceptible of infecting more than a single host.

Location.—Washington, D. C.

Date begun.—1901.

Results.—Improved methods for propagating and testing cultures have been developed and the character and proper name of the organism determined, and studies have been made on the intervarietal inoculation of soy beans and of the commonly accepted cross-inoculations of the alfalfa group, the clover group, and the garden-pea group, all of which have been verified in pure culture. Publication: "Variations in Nodule Formation," Journal of the American Society of Agronomy, vol. 8, No. 2.

Probable date of completion.—1917.

Assignment.—K. F. Kellerman, L. T. Leonard.

Proposed expenditures, 1916-17.—\$1,000.

Total, Distribution and Study of Legume Bacteria, \$13,120, including \$720 statutory.

INVESTIGATIONS IN SOIL BACTERIOLOGY.**Investigations of the Organisms Causing Decomposition in Organic Material in Soils:**

Object.—To determine the causes of the different kinds of decomposition of organic matter and the conditions under which humus is produced in soils; to study the causes of the varying effects of green manures, barnyard manures, and crop residues in restoring, maintaining, and increasing the fertility of the soil, and to develop the rules for their most successful application.

Investigations of the Organisms Causing Decomposition in Organic Material in Soils—Continued.

Procedure.—Laboratory, greenhouse, and field studies of the biological conditions affecting plant growth upon various soils are conducted, as well as laboratory studies of the decomposition of the different organic manures. Greenhouse and field tests of the efficiency of these substances under different conditions are also carried out.

Location.—Washington, D. C.

Date begun.—1909.

Results.—It has been found that the formation of nitrate in different soils varies widely under the influence of the different green manures, barnyard manures, and crop residues. The nitrogen efficiency of these materials, tested in pot experiments, ranges, accordingly, between 0 and 80 per cent. In the field, mulching with green manures, first applied in the autumn of 1915, has already exerted a very favorable effect on the physical structure of the soil and on its life. These preliminary experiments have also furnished interesting details concerning the experimental error in laboratory, greenhouse, and field tests.

Publications: "Further Experiments in the Destruction of Fly Larvæ in Horse Manure," Department Bulletin 245; "Some Filamentous Fungi Tested for Cellulose-Destroying Power," Botanical Gazette, vol. 60, No. 2; "The Determination of Reducing Sugars," Journal of Biological Chemistry, vol. 23, No. 1; "The Enzymes of *Aspergillus Terricola*," Journal of Biological Chemistry, vol. 19, No. 4; "A New Method of Precipitating Cellulose for Cellulose Agar," Centralblatt für Bakteriologie, Band 44, 1915, No. 17-23.

Assignment.—K. F. Kellerman, F. Löhnis, R. C. Wright, F. M. Scales, N. R. Smith.
Proposed expenditures, 1916-17.—\$8,840.

Investigations of the Nitrifying, Denitrifying, and Nitrogen-Fixing Bacteria:

Object.—To determine the relationships of the organisms which fix atmospheric nitrogen and those which cause nitrification and denitrification in soils, including a study of the morphology and physiology of *Bacillus azotobacter* and other important soil bacteria.

Procedure.—The work includes laboratory investigations at Washington, D. C., also laboratory and field studies at Riverside, Cal., in relation to citrus orchards, to determine the relationship between the available nitrogen in the soil and certain kinds of malnutrition of plants.

Location.—Washington, D. C., and Riverside, Cal.

Date begun.—1912.

Results.—It has been discovered that *B. azotobacter*, as well as all other bacteria, develops in regular life cycles, entirely unknown heretofore. This fact, when thoroughly studied, will become of considerable importance for soil biology as well as for all other branches of agricultural and medical bacteriology.

Symptoms of malnutrition of citrus trees developed both from an excessive supply of nitrate in the soil and from an insufficient supply of nitrate have been observed. Changes in methods of protecting the soil from evaporation and systems for applying water in irrigation ditches appear to offer means for correcting this difficulty.

Assignment.—K. F. Kellerman, F. Löhnis, I. G. McBeth.

Proposed expenditures, 1916-17.—\$5,840.

Study of the Relation of Soil Bacteria to Growth of Crop Plants:

Object.—To determine the effect upon plants of products of bacterial growth.

Procedure.—Laboratory, greenhouse, and field studies are conducted to determine the influence of certain field crops upon the transformation of soil nitrogen. Nonleguminous crops are grown under strictly control conditions on three classes of soil to determine the relative quantities of total nitrogen and nitrate nitrogen remaining in the soil after the removal of different crops, the relative quantities of nitrogen recovered in the crops, and the influence of the growth of these crops upon the ammonifying, nitrifying, and nitrogen-fixing powers of the soil. Work is also under way on the influence of the production of these crops upon the growth of succeeding crops in the same soil.

Location.—Washington, D. C.

Date begun.—1910.

Results.—No conclusions of practical importance have yet been developed. Publications: "Mutual Influence of Certain Crops in Relation to Nitrogen," Journal of the American Society of Agronomy, vol. 6, Nos. 4-5; "Growing Plants in Large Containers under Control Conditions," Journal of the American Society of Agronomy, vol. 8, No. 2; "The Action upon Soil Nitrogen of Certain Crops," Science, n. s. vol. 43, No. 1105.

Study of the Relation of Soil Bacteria to Growth of Crop Plants—Continued.*Assignment.*—K. F. Kellerman, F. Löhnis, F. M. Scales, R. C. Wright.*Proposed expenditures, 1916-17.*—\$1,650.**Total, Investigations in Soil Bacteriology, \$16,330, including \$1,680 statutory.****Total, Soil-Bacteriology Investigations, \$39,050, including \$8,000 statutory.**

[Research.]

PLANT-NUTRITION INVESTIGATIONS.**General Investigations in Plant Nutrition:***Object.*—To study the growth, development, and composition of plants as affected by nutrition, more particularly the factors of nutrition controlling the quantity of oil produced in important oil-bearing seeds, the functions of the plant-food elements in nutrition, and the relative plant-food requirements of crops commonly grown in rotation.*Procedure.*—Laboratory, greenhouse, and field investigations are conducted. In the work on the oil content of seeds experimental material is grown in the field and in the greenhouse under controlled conditions of temperature, light, moisture, and food supply, so as to determine the optimum conditions for growing oil-producing plants. In studying relative plant-food requirements the crop plants are grown on field plats so handled as to insure comparable conditions as to food requirements. In all cases the necessary laboratory study of the material is made. Further work on these problems should be continued along substantially the same lines, to give way as completed to other similar problems.*Cooperation.*—North Carolina and Maryland experiment stations.*Location.*—Upper Marlboro, Md., Oxford, N. C., Arlington Farm, Va., and Washington, D. C.*Date begun.*—1906.*Results.*—The chief feature of the work for the past year was an experimental study of crop rotation, in which some very important results were obtained on crop relationships and the relative food requirements of crop plants as a basis for rational rotation of crops. Striking effects of certain crop plants on the yields of succeeding crops were obtained. In the work on oil content as affected by the nutrition of the plant, additional data have been obtained on the relation of the water supply to oil formation, and preliminary results have been obtained on the rôle of temperature in oil formation.Results covering the more general aspects of the work on the production of oil in seeds, of interest both to farmers and the many industries requiring vegetable oils, were published in the *Journal of Agricultural Research*, vol. 3, No. 3. It has been shown that the nutrition conditions of the plant play a leading part in oil production in seeds, and when the work is completed it should be possible to indicate the soil and climatic conditions best adapted to growing oil-producing crops.*Assignment.*—W. W. Garner, H. A. Allard, W. M. Lunn.*Proposed expenditures, 1916-17.*—\$9,850.**Nutrition of the Date Palm:***Object.*—To determine the optimum conditions for nutrition and fruit production of the date palm, and to develop therefrom a rational system of employing fertilizers in the different date-growing regions.*Procedure.*—Laboratory experiments are conducted at Washington, D. C. Field experiments are carried on at Indio and Mecca, Cal., and Tempe, Ariz., for the purpose of examining orchard conditions and establishing rational fertilizer practices for the different regions.*Location.*—Washington, D. C., Indio and Mecca, Cal., and Tempe, Ariz.*Date begun.*—1912.*Results.*—In the alkali soils which bake and thereby reduce the productiveness of the date palm it has been found that the application of numerous small quantities of calcium sulphate improves the texture of the soil and also increases the yield and quality of the date and that an unbalanced or insufficient supply of food materials appears to injure the flavor of the cured dates. The most effective combination of fertilizer, as well as other food materials, has not yet been determined.

Nutrition of the Date Palm—Continued.*Probable date of completion.*—1918.*Assignment.*—K. F. Kellerman.*Proposed expenditures, 1916-17.*—\$1,100.**Total, Plant-Nutrition Investigations, \$10,950.**

[Research.]

SOIL-FERTILITY INVESTIGATIONS.**Supervision:***Object.*—To provide supervision, clerical assistance, and the miscellaneous administrative requirements for the proper conduct of investigations in soil fertility.*Location.*—Washington, D. C.*Date begun.*—1904.*Assignment.*—Oswald Schreiner.*Proposed expenditures, 1916-17.*—\$4,440.**Maintenance of Soil Fertility:***Object.*—To study problems in the management and upbuilding of specific soil types, the best systems of rotation, and the effect of fertilizers. The work includes laboratory investigations on the composition of humus and soil organic matter generally.*Procedure.*—Laboratory investigations and field observations are made. Prominent among these are field studies on the soil conditions and biochemical relationships in fields infected with powdery scab of the potato, in cooperation with the Office of Cotton and Truck Disease Investigations.*Cooperation.*—Bureau of Soils; informal cooperation with individual farmers relative to powdery scab of potatoes.*Location.*—Washington, D. C.; field studies in connection with the powdery scab of the potato at Presque Isle, Caribou, and other points in Maine.*Date begun.*—1904.*Results.*—The nature of nitrogen and sulphur compounds in peat has been determined; several additional organic compounds isolated, their distribution established, and the results published; alkali salts shown to be diminished by green manuring; organic fertilizers studied and the organic compounds composing the same determined, this investigation throwing much light on the availability of nitrogen; relation between powdery scab of the potato and soil type or soil conditions determined. Information has been disseminated regarding specific soil types and their management, the chemical nature of humus determined, and many substances isolated and identified and their distribution established.*Assignment.*—Oswald Schreiner, B. E. Brown, E. C. Lathrop, A. P. Dachnowski, E. H. Walters, L. A. Hurst, A. M. Jackson.*Proposed expenditures, 1916-17.*—\$6,476.**Causes of Unproductive Soils:***Object.*—To study organic substances causing infertility, such as result in the failure of specific crops, of orchards, die-back in citrus groves, clover-sick soils, etc.*Procedure.*—Chemical laboratory investigations on soils from unproductive areas are conducted; also investigations of the causes of citrus die-back, in cooperation with the Agricultural Experiment Station of the University of Florida, and field and laboratory studies of clover-sick soils, in cooperation with the Office of Forage-Crop Investigations and with individual farmers in the regions most affected.*Cooperation.*—Florida Experiment Station; informal cooperation with individual farmers.*Location.*—Washington, D. C., Scottsburg, Ind., and Gainesville, Fla.*Date begun.*—1904.*Results.*—Several additional organic compounds harmful to crop growth have been isolated from unproductive soils. Clover-sick soils are under investigation. Some of these compounds have been obtained from soils on which die-back of the orange occurs. A number of harmful substances have been isolated and identified and their occurrence determined.*Assignment.*—Oswald Schreiner, J. J. Skinner, A. P. Dachnowski, E. H. Walters, L. E. Wise, A. M. Jackson.*Proposed expenditures, 1916-17.*—\$5,052.

Transformation and Formation of Soil Humus by Biochemical Factors:

Object.—To study changes in soil organic matter and the formation of organic compounds by microorganisms and higher plants.

Procedure.—Biochemical-laboratory investigations are conducted, including a study of the nature of compounds formed in the destruction of cellulose by soil organisms, in cooperation with the Office of Soil-Bacteriology Investigations.

Location.—Washington, D. C.

Date begun.—1904.

Results.—The relation between soil activity and hydrogen in concentration established and a method of measurement perfected; behavior of organic fertilizers, like dried blood, in soils determined and the significance of protein hydrolysis and synthesis in relation to the availability of the nitrogen ascertained. It has been found that oxidation bears a fairly definite relation to soil fertility. Organic chemical compounds have been obtained from molds and soils identical in composition. The results secured have been applied to formation of humus.

Assignment.—Oswald Schreiner, E. C. Lathrop, E. H. Walters, F. R. Reid, L. J. Gillespie.

Proposed expenditures, 1916-17.—\$6,256.

Origin of Organic Constituents in Soils:

Object.—To study the chemical transformation of organic matter in soils, which results in the formation of the constituents isolated from soils.

Procedure.—Biochemical laboratory investigations are made on the transformation of various organic materials in different soil types.

Location.—Washington, D. C.

Date begun.—1904.

Results.—The origin of several acids and aldehydes in soils has been determined. Organic matter added to soils has been found to break down along definite lines, yielding compounds some of which had previously been isolated from field soils.

Assignment.—Oswald Schreiner, B. E. Brown, E. C. Lathrop, E. H. Walters.

Proposed expenditures, 1916-17.—\$5,050.

Means for Improvement of Unproductive Soils:

Object.—To determine the fertilizer and lime requirements of soils, the action of compounds isolated from soils, and the effect of fertilizers on these.

Procedure.—Greenhouse and nutrient-solution studies and field tests are made with certain fertilizers to study their action on the effect of the different soil compounds isolated from soils.

Cooperation.—Experiment stations of Pennsylvania and New York (Cornell).

Location.—Washington, D. C., Arlington Farm, Va., State College, Pa., and Ithaca, N. Y.

Date begun.—1904.

Results.—The action of soil aldehydes on crops in the field and their elimination have been ascertained. Vanillin has been found to be counteracted by nitrate, salicylic aldehyde, and phosphate fertilizer, resulting in improved crop yields. The effect of these aldehydes varies in degree with the soil, and it is shown that in some soils the aldehydes persist, whereas in others they disappear. Liming facilitates their disappearance. Information has been disseminated regarding specific soils, the properties of a considerable number of compounds ascertained, and the ameliorating action of specific fertilizers determined.

Assignment.—Oswald Schreiner, J. J. Skinner, A. P. Dachnowski, F. R. Reid, J. H. Beattie.

Proposed expenditures, 1916-17.—\$4,236.

Effect of Fertilizers and Soil Amendments:

Object.—To study the various soil factors as influenced by fertilizers and soil amendments, such as lime, manganese, etc., in the field and with different crops.

Procedure.—Plot and field work is carried on, including a study to determine the germination and yield differences in wheat grown in connection with fertilizer ratio experiments, in cooperation with the Office of Cereal Investigations.

Cooperation.—Pennsylvania Experiment Station and Bureau of Chemistry.

Location.—Washington, D. C., Arlington Farm, Va., and State College, Pa.

Date begun.—1904.

Effect of Fertilizers and Soil Amendments—Continued.

Results.—The action of catalytic fertilizers like manganese is shown to be dependent on soil reaction. Manganese was ineffective for five years under acid-soil conditions. After correcting this acidity the manganese became very effective in producing an increase in crop yield and in soil oxidation. It has been shown that certain fertilizers, more than others, tend to produce soil acidity. Liming has been studied. It has been shown that not only are acid conditions remedied but oxidation is increased and harmful soil compounds destroyed.

Assignment.—Oswald Schreiner, J. J. Skinner, F. R. Reid, J. H. Beattie, Henry Winckelmann.

Proposed expenditures, 1916-17.—\$5,090.

Total, Soil-Fertility Investigations, \$36,600, including \$1,400 statutory.

[Research.]

CROP-ACCLIMATIZATION INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To provide for clerical and administrative routine, laboratory experiments, and other general details connected with field investigations.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—O. F. Cook, G. N. Collins.

Proposed expenditures, 1916-17.—\$5,704, including \$4,440 statutory.

ACCLIMATIZATION, ADAPTATION, AND BREEDING OF COTTON.**Acclimatization of Weevil-Resistant Varieties:**

Object.—To secure varieties better suited to cultivation in weevil-infested regions and to acclimatize such varieties in the United States.

Procedure.—Weevil-infested regions in tropical America are visited to study the cultural conditions, habits, and special characters of the native varieties of cotton. Select stocks of the more promising foreign varieties are brought to the United States for further selection and testing in various parts of the cotton belt in comparison with the varieties in regular cultivation. Much of the experimental work is done in cooperation with field stations conducted by the Offices of Western Irrigation Agriculture and Crop Physiology and Breeding Investigations of the Bureau of Plant Industry.

Cooperation.—Individual farmers.

Location.—Mexico, Central America, and the cotton belt of the United States.

Date begun.—1905.

Results.—Varieties with weevil-resistant characters have been discovered in Mexico and Central America and acclimatized in the United States. Superior strains have been bred from these imported stocks and are being established in cultivation in weevil-infested regions of the United States. Four of the newly acclimatized types—Durango, Acala, Kekchi, and Tuxtla—have yielded very promising varieties. In addition to special features that lessen the danger of weevil injury, the new varieties are very early and productive, with relatively larger bolls and longer lint than the types previously known to our planters. The Durango cotton is now being grown in commercial quantities in several districts, being preferred on account of the open habit of growth, strong central stalk, high yield, and excellent quality of lint.

Assignment.—O. F. Cook.

Proposed expenditures, 1916-17.—\$6,417.

Cotton Culture under Weevil Conditions:

Object.—To secure information concerning the local modifications of cultural methods necessitated by the presence of the boll weevil.

Procedure.—The structure and habits of growth of different kinds of cotton are studied under different conditions and with different methods of planting, thinning, and cultivation. The behavior of the plants is observed, especially the extent to which their habits can be controlled by cultural methods. Much of the experimental work has been done in southern Texas at the San Antonio Experiment Farm maintained by the Office of Western Irrigation Agriculture, of this bureau.

Cotton Culture under Weevil Conditions—Continued.

Cooperation.—Individual farmers, and Office of Extension Work in the South, States Relations Service.

Location.—That part of the cotton belt infested by the boll weevil.

Date begun.—1905.

Results.—Cooperative experiments in the application of the single-stalk system of cotton culture have been conducted in many localities in different parts of the cotton belt. A series of 21 demonstration experiments conducted in 1915 in nine parishes and counties of Louisiana, Arkansas, and North Carolina showed a general increase for the new system. In several instances increases of more than 20 per cent were obtained. A report of this work has been submitted for publication. The advantage of the system lies in securing earlier and larger crops under short-season conditions. The system is based on the discovery of two facts—that the cotton plant has two distinct kinds of branches and that the formation of the branches can be controlled largely by cultural means. Suppression of the vegetative branches or secondary stalks of the plants insures a better development of the lower fruiting branches of the main stalk where the early crop is produced. Experiments with the new single-stalk system conducted in Virginia, South Carolina, Texas, Oklahoma, Arizona, and California show that the improved method is effective in promoting earliness, and increases of 20 to 100 per cent in the yield of seed cotton have been recorded.

Assignment.—O. F. Cook, P. V. Cardon.

Proposed expenditures, 1916-17.—\$8,133.

Cotton Culture in Arid Regions:

Object.—To ascertain the factors of cotton culture in arid regions and to determine the possibilities of extending cotton culture in portions of Texas and other Southwestern States where the boll weevil does not exist or is less destructive on account of the dry climate.

Procedure.—Varieties of cotton and cultural methods are tested in relation to drought resistance and other factors that affect their suitability in dry climates, with or without irrigation. Much of the work is done under informal cooperative agreements with the Offices of Western Irrigation Agriculture, Dry-Land Agriculture, and Crop Physiology and Breeding Investigations, of the Bureau of Plant Industry, at local stations conducted by these offices in Texas, New Mexico, Arizona, and California.

Cooperation.—Individual farmers.

Location.—Arizona, California, New Mexico, and Texas.

Date begun.—1906.

Results.—The development of superior varieties and improved methods of culture has been largely responsible for the extension of cotton growing into the more arid regions of the southwestern United States. Durango cotton, acclimatized from Mexico, has shown distinct advantages over other long-staple Upland varieties in drought resistance, as well as in adaptation to irrigation culture, and it is becoming one of the leading crops of this region, particularly in the Imperial Valley of California. The first observations and experiments that led to the discovery of the new single-stalk system of culture were made in connection with the Egyptian cotton and have contributed to the establishment of the Egyptian-cotton industry of the Salt River Valley of Arizona. As applied to the Egyptian cotton, the single-stalk system not only induces earlier fruiting and tends to insure larger crops, but greatly facilitates the picking of the cotton. Thus the cost of production is lessened while the yields are increased.

Assignment.—O. F. Cook.

Proposed expenditures, 1916-17.—\$1,283.

Local Adjustment and Adaptation of Cotton Varieties:

Object.—To ascertain the nature and importance of special characters or differences that determine the agricultural values of varieties of cotton and their suitability to cultivation under particular local conditions.

Procedure.—The same series of varieties is planted under different conditions in the several sections of the cotton belt and changes of behavior observed; also differences between stocks of the same variety grown in the same place, comparing the product of locally grown seed with that of seed raised in other places.

Cooperation.—Individual farmers.

Location.—Cotton belt of the United States.

Date begun.—1909.

Local Adjustment and Adaptation of Cotton Varieties—Continued.

Results.—Experiments in many localities indicate a general superiority of varieties that have been bred in Texas from Mexican or Central American stocks over the type represented by most of the short-staple varieties grown in the Southeastern States. Experiments have shown that locally grown and selected seed usually gives better results than seed of the same variety brought in from some other region where the conditions of growth are different. Selection for local adjustment is shown to be necessary before the full possibilities of a variety in a given district can be determined. Varieties tested on a basis of local adjustment prove to be adapted to a wide range of natural conditions, thus making possible a more extensive utilization of superior varieties and showing that the present multiplicity of varieties is unnecessary as well as undesirable. The Durango variety is grown successfully in Virginia and other Southeastern States, as well as in the Imperial Valley of California. Study of local-adjustment problems has also led to a recognition of the advantages to be gained by the organization of cotton-growing communities for the exclusive production of a single superior variety so that stocks may be kept pure and uniform, thus increasing production and giving both seed and lint a higher market value.

Assignment.—O. F. Cook, P. V. Cardon, G. S. Meloy.

Proposed expenditures, 1916-17.—\$2,567.

Breeding and Preservation of Cotton Varieties:

Object.—To improve varieties of cotton by selection of the best strains and to develop improved methods of selection in order that adequate supplies of pure seed of superior varieties may be maintained.

Procedure.—Detailed tests and comparisons of varieties are made to learn the characters and habits which are of the most importance from the standpoint of production. Methods of breeding and selection are studied from the standpoint of practicability of application and efficiency in maintaining the uniformity of the stocks.

Cooperation.—Individual farmers.

Location.—Cotton belt of the United States.

Date begun.—1909.

Results.—Varieties of cotton have been developed that are superior to those in general cultivation, not only in yield and earliness but in the length, quality, and uniformity of the staple. These varieties are being established in cultivation and supplies of pure seed are being maintained by improved methods of selection. Study of the plant characters of the different varieties has made it possible to recognize and remove hybrids or aberrant individuals from the fields, thus protecting select stocks from contamination and deterioration through loss of uniformity. Five varieties are now being sent out through the congressional seed distribution, four of which have attained prominence. The Lone Star variety, representing the Texas big-boll type of cotton, is becoming recognized as one of the leading varieties in Texas, Oklahoma, and adjacent States. The Trice variety, an extra-early sort bred from a local stock in western Tennessee, has given excellent results across the northern rim of the cotton belt and in weevil-infested regions where a very short season variety is needed. The Columbia variety, also known as Webber, has been grown extensively in South Carolina and adjacent States but now seems likely to give place to the Durango cotton, which matures in a shorter season. The methods of distributing the seed, under the established congressional system, have also been improved so as to assist in establishing superior varieties in regular cultivation in communities that can serve as centers of production of pure seed and thus make possible a wider utilization of the varieties. This is accomplished by following the general distribution of small trial packages, with a special distribution of larger quantities of seed in communities that show the best prospect of using a variety extensively and producing supplies of good seed.

Assignment.—O. F. Cook, G. S. Meloy.

Proposed expenditures, 1916-17.—\$12,266.

Total, Acclimatization, Adaptation, and Breeding of Cotton, \$30,666.

ACCLIMATIZATION, ADAPTATION, AND EXTENSION OF CORN.**Acclimatization, Adaptation, and Extension of Corn:**

Object.—To secure varieties of corn adapted to special conditions outside of the principal corn-growing States, particularly in the subtropical Gulf region, the arid Southwest, and the Pacific Coast States.

Acclimatization, Adaptation, and Extension of Corn—Continued.

Procedure.—The behavior of the different types and varieties of corn in experimental plantings in the United States and in foreign countries are compared and studied, in order to ascertain the special characters or habits of growth that render the varieties adapted to particular conditions or uses and to ascertain the best methods of utilizing adaptive characters in developing superior varieties by selection or hybridization.

Cooperation.—Individual farmers and the California Experiment Station at Berkeley.

Location.—Central and South America, Mexico, and the tropical, subtropical, and arid regions of the United States.

Date begun.—1905.

Results.—It was found in 1915 that the coast region of California affords favorable conditions for the development of the highly specialized types of corn native in the cool highlands of Bolivia and Peru. Studies of the inheritance of special characters have been reported for publication, giving evidence of fundamental differences between the heredity of corn and other crop plants that must influence the methods of breeding. Outside of the United States corn has been found growing and producing satisfactory yields under a much wider range of climatic and soil conditions than our varieties would permit. Studies of a number of these foreign varieties have shown that they possess adaptations that especially fit them to withstand the extreme conditions under which they have been produced. Through the introduction and hybridization of these varieties it has been possible to develop strains having resistance to low temperatures, drought, high winds, and insect injuries.

Assignment.—G. N. Collins, J. H. Kempton.

Proposed expenditures, 1916-17.—\$6,800.

ACCLIMATIZATION AND ADAPTATION OF TROPICAL PLANTS.**Acclimatization and Adaptation of Tropical Plants:**

Object.—To determine the possibilities of acclimatizing and establishing in the United States superior varieties of crop plants that are natives of tropical countries.

Procedure.—Investigations are begun in foreign countries in order to learn the native conditions, habits, special characters, cultural requirements, and uses, and to select the best strains for acclimatization, breeding, and testing in the United States. Explorations and experiments are conducted in cooperation with the Offices of Foreign Seed and Plant Investigations, Western Irrigation Agriculture, and Crop Physiology and Breeding Investigations, of this bureau.

Cooperation.—Private growers, nursery firms, and park authorities in the Southern and Southwestern States.

Location.—Foreign countries, Washington, D. C., Southern and Southwestern States, and the tropical and subtropical possessions of the United States.

Date begun.—1909.

Results.—During recent expeditions to the tableland regions of Guatemala and Peru new varieties of many tropical crop plants have been studied and seeds or propagating materials secured, including cotton, corn, potatoes, cassava, and other root crops, vegetables and fruits, such as a hardy hard-shelled avocado better adapted to commercial production than the varieties previously known. Some of these are likely to be of use on the Pacific coast and other districts with cool climates and others in tropical districts of southern California and Florida. Many of the imported stocks that behave abnormally and are unproductive when first planted in the United States show gradual improvement in subsequent seasons and eventually produce useful varieties. The discovery of special adaptive characters of cotton and corn are among the results of these tropical investigations, and other tropical crops are being studied chiefly in connection with expeditions and experimental work with cotton and corn varieties. General information on tropical economic plants and vegetable products is furnished. Several millions of dollars undoubtedly have been saved to the American public by publishing the results of investigations of rubber culture, which served as an effective warning against bad investments in planting enterprises which have since proved to be worthless. Studies of coffee, cacao, and bananas have resulted in the discovery of new cultural improvements of importance to growers of these crops.

Assignment.—O. F. Cook, H. Pittier, C. B. Doyle.

Proposed expenditures, 1916-17.—\$3,850.

Total, Crop-Acclimatization Investigations, \$47,020, including \$4,440 statutory.

[Research.]

DRUG-PLANT, POISONOUS-PLANT, PHYSIOLOGICAL, AND FERMENTATION INVESTIGATIONS.

SUPERVISION.

Supervision:

Object.—To provide supervision, clerical assistance, and the miscellaneous supervisory and administrative needs of the projects of this group.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—R. H. True, W. W. Stockberger.

Proposed expenditures, 1916-17.—\$10,399, including \$6,725 statutory.

DRUG AND RELATED PLANTS AND THEIR PRODUCTS.

Oil-Seed Crop Production:

Object.—To obtain information regarding the oil-seed crop possibilities of various sections of the United States and determine what oil seeds may be successfully grown and profitably utilized; to secure data on the best cultural methods, including crop rotation, the use of fertilizers, methods of harvesting and threshing, etc.; to increase the agricultural resources of the United States by developing new sources of fatty oils, and to extend the use of oil-seed products by manufacturers using these or similar products.

Procedure.—Row and plat tests are made in the case of new crops, followed by field tests of promising crops. Cultural requirements are determined from experimental plantings and the best methods of treatment tested on a field basis, in cooperation with practical farmers. Commercial tests of various oil seeds will be made, in cooperation with manufacturers of vegetable oils.

Cooperation.—Individual farmers and manufacturers.

Location.—South Carolina and points in various other States.

Date begun.—1916 as a separate project; work along this line carried on since 1908 under the project "Miscellaneous Field and Laboratory Work on Drug and Related Plants."

Results.—Information has been obtained on the possibilities for extending the production of a number of oil-seed crops, including sunflowers, castor beans, and sesame. Trial cultures have been made with several oil-seed crops produced abroad but new to the United States.

Assignment.—W. W. Stockberger, Thos. B. Young.

Proposed expenditures, 1916-17.—\$4,130.

Essential-Oil Crop Production:

Object.—To introduce essential-oil crops into commercial culture in the United States, develop improved types of essential-oil plants, and work out economical methods of harvesting these crops and preparing the oils therefrom.

Procedure.—Studies are made of the culture of various plants yielding volatile oils, including their propagation, planting, tillage, and fertilization. Individual plants of the most desirable types are selected and propagated. Methods of harvesting the plants and distilling the oils are studied and the machinery and apparatus needed in these operations devised or improved when necessary. The oils or the marketable products therefrom are tested, in cooperation with manufacturers using these or similar products. Data on the commercial production of essential-oil crops are obtained from field trials and from cooperators' records of the sales of products.

Cooperation.—Orange County (Fla.) Fair Association and individual growers.

Location.—Orlando, Fla., and other points in the Gulf States.

Date begun.—1916 as a separate project; work has been in progress along this line since 1908 under the project "Miscellaneous Field and Laboratory Work on Drug and Related Plants."

Results.—Data in manuscripts entitled "Commercial Production of Thymol from Horsemint (*Monarda punctata*)," "Commercial Production of Lemongrass Oil," and "Commercial Production of Sweet Orange Oil from Waste Oranges," which are ready for publication. The production of the oil of sweet oranges at relatively low cost has been made possible by the construction of a practical machine which peels oranges at the rate of 125 per minute. Improvements have also been made in the machinery used in harvesting horsemint.

Assignment.—G. A. Russell.

Proposed expenditures, 1916-17.—\$3,440.

Vegetable-Oil Investigations:

Object.—The study of the fixed and volatile oils yielded by wild and cultivated American plants, with reference to their technical value.

Procedure.—Wild aromatic plants are investigated as possible new sources of volatile oils. Such oils when obtained are analyzed to determine their possible commercial value in the perfumery, flavoring extract, and soap-making industries. The fixed and volatile oils from plants now cultivated on a commercial scale are subjected to laboratory tests to determine their quality and quantity and the technical value of their constituents. Study is also made of the effects of cultivation, time of harvest, and climatic and soil conditions on the yield and quality of these oils.

Location.—Washington, D. C.; crop facilities furnished by the various testing gardens of this office, located at Arlington Farm, Va., Madison, Wis., Orlando, Fla., and Ebenezer, S. C.

Date begun.—1906.

Results.—Much information has been obtained regarding the probable utility of numerous vegetable oils. Limonene, a turpentine substitute, has been discovered in the common fireweed. A substitute for linseed oil had been demonstrated in raisin waste. Other results may be found in Bureau of Plant Industry Bulletin 195, "The Production of Volatile Oils and Perfumery Plants in the United States"; Bureau of Plant Industry Bulletin 235, "Wild Volatile Oil Plants and their Economic Importance"; Journal of Agricultural Research, vol. 2, No. 2, "The Aroma of Hops with Special Reference to the Effect of Geographic Source upon the Yield of Hops," and in an article entitled "The Effect of Cultural and Climatic Conditions upon the Yield and Quality of Peppermint Oil," now ready for publication.

Assignment.—Frank Rabak.

Proposed expenditures, 1916-17.—\$1,555.

Investigations of the Active Constituents of Medicinal Plants:

Object.—To ascertain the influence of climate and cultural conditions on the active constituents of medicinal plants, to determine the individual variation in the alkaloidal content of medicinal plants as a basis for improvement by selection, and to obtain data regarding the effect of time of collection and mode of preparation on activity of plant drugs.

Procedure.—Individual plants grown under different conditions are analyzed and the alkaloidal content or degree of toxicity noted. Individual plants having a common parentage are grown under similar conditions and analyzed, the results giving a basis for selecting desirable types for further propagation. Various medicinal roots, leaves, etc., collected at different seasons and in varying stages of growth are analyzed to determine the procedure which gives the best quality of drug.

Location.—Washington, D. C.

Date begun.—1916 as a separate project; work developed in connection with other projects since 1912.

Results.—A new strain of belladonna has been developed which has a greatly increased alkaloidal content and points the way to a very great improvement in the quality of this drug as usually found on the market. Data published in Journal of Agricultural Research, vol. 1, No. 2, "Individual Variation in the Alkaloidal Content of Belladonna Plants," and Department Bulletin 306, "Some Effects of Selection on the Production of Alkaloids in Belladonna."

Assignment.—A. F. Sievers.

Proposed expenditures, 1916-17.—\$1,780.

Breeding of Medicinal Plants:

Object.—To secure improved strains of medicinal plants by breeding.

Procedure.—An attempt is being made to develop new and advantageous forms of the various plants used in medicine. Individual plants are sought possessing in the highest degree the desired qualities as a foundation for strains or varieties of greater economic value than we now possess. After desirable characters have been well developed under proper selective methods, accompanied by specially favorable cultural conditions, crossing is resorted to for combining diverse characteristics and increasing variation.

Location.—Washington, D. C., Arlington Farm, Va., and Glenn Dale, Md.

Date begun.—1916.

Breeding of Medicinal Plants—Continued.

Results.—About 150 species of drug and related plants are under experimental culture on the heavy clay at Arlington Farm, Va., and on sandy loam near Glenn Dale, Md. Permanent plantings are being made of many of these species at Arlington Farm to furnish further material for selection and breeding.

Assignment.—W. Van Fleet.

Proposed expenditures, 1916-17.—\$1,500.

Commercial Production of Drug and Related Plants in the Upper Mississippi Valley:

Object.—To determine, first by small experimental cultures and then by actual crop tests in the field, what drug and related plants can be grown successfully and profitably in the upper Mississippi Valley, and to investigate methods of handling these crops and of preparing the products for market.

Procedure.—Plants believed to be adapted to the region in question are grown in small experimental plats and the details of their cultural requirements worked out. Those which appear promising are then tested under the actual conditions of crop production, usually in cooperation with practical farmers. The cost of production and marketing and the return from sales are recorded for each crop.

Cooperation.—University of Wisconsin, at Madison, Wis., Omro Drug Plant Co., at Omro, Wis., and Karl S. Smith, at Fond du Lac, Wis.

Location.—Madison, Omro, and Fond du Lac, Wis.

Date begun.—1916 as a separate project; work has been in progress along this line since 1908 under the project "Miscellaneous Field and Laboratory Work on Drug and Related Plants."

Results.—Definite data secured regarding the cultural requirements of more than 100 drug and related plants; information disseminated on commercial possibilities for these plants.

Assignment.—W. W. Stockberger.

Proposed expenditures, 1916-17.—\$1,000.

Investigations of Plant Waste Products as Commercial Sources of Fixed Oils, Volatile Oils, and Other Valuable Constituents:

Object.—To determine the commercial value of wastes resulting from canning, packing, or other methods of preparing plant products.

Procedure.—Sources of wastes resulting from various canning and packing operations are determined and information secured regarding the annual output and disposal of various waste products. Samples are taken of the wastes occurring in promising quantities for investigation in the laboratory, where the various important constituents are extracted and methods devised for their preparation in useful form.

Cooperation.—Canners, packers, and various manufacturers.

Location.—Washington, D. C.

Date begun.—1916 as a separate project; previously the work on waste products has been done under the project "Vegetable Oil Investigations."

Results.—A study of certain by-products of the fruit and canning industry has shown important sources of value in waste products heretofore unutilized. The more important results obtained to date may be found in B. P. I. Bulletin 133, "Peach, Apricot, and Prune Kernels as By-Products of the Fruit Industry of the United States," B. P. I. Bulletin 276, "The Utilization of Waste Raisin Seeds," and Department Bulletin 350, "The Utilization of Cherry By-Products."

Assignment.—Frank Rabak.

Proposed expenditures, 1916-17.—\$1,375.

Utilization of Drug and Related Crop Wastes:

Object.—To determine the value and possible utility of drug and related crop wastes.

Procedure.—The spent plant material resulting when volatile-oil crops are distilled will be tested for value as stock feeds or fertilizers. Useful constituents will be sought in the crop by-products resulting from the preparation of crude plant drugs. Studies will be made of the best methods of utilizing waste stalks, leaves, hulls, or other plant parts rejected in working up various drug and related crops.

Location.—Washington, D. C., and Orlando, Fla.

Date begun.—1915.

Results.—Spent herb of hoarsmint (*Monarda punctata*) has been shown to have a fertilizer value such that, if returned to the soil, would restore most of the nutrient materials removed by this crop.

Utilization of Drug and Related Crop Wastes—Continued.*Assignment.*—W. W. Stockberger, S. C. Hood, G. A. Russell.*Proposed expenditures, 1916-17.*—\$490.**Establishment of the Camphor Industry:***Object.*—The introduction of an industry in the production of camphor in the United States.*Procedure.*—Field and laboratory experiments are conducted, including tests of the camphor content and distribution in grown trees, the experimental propagation, cultivation, and selection of the plants, the determination of the best methods of culture, and the development of improved machinery for use in the production of camphor.*Cooperation.*—Land and buildings furnished by the Orange County (Fla.) Fair Association and individual growers.*Location.*—Orlando and other points in Florida.*Date begun.*—1908.*Results.*—As a direct outcome of the department's work on camphor, several large commercial enterprises have been undertaken and many smaller plantings made, but none of the latter has yet reached the stage of active commercial operations. Data published in the Department Yearbook for 1910.*Probable date of completion.*—1918.*Assignment.*—G. A. Russell.*Proposed expenditures, 1916-17.*—\$1,520.**Hop-Improvement Investigations:***Object.*—To improve methods of growing, curing, handling, and standardizing American hops.*Procedure.*—This work includes a physiological study of the root disease of hops and of the influence of various fertilizers on yield and quality, the testing of various varieties to determine their relative value, a study of the cost of production with relation to the present method of handling the crop, and an investigation of the chemical constituents which determine the value of hops with special reference to the modification of these constituents by cultural treatment.*Cooperation.*—Land and crop facilities are furnished by hop growers.*Location.*—Field headquarters at Perkins, Cal.; test of areas under special handling in Oregon and field investigations throughout the hop-growing regions of the Pacific Coast States and New York; and laboratory studies in Washington, D. C.*Date begun.*—1905.*Results.*—Results have been published in Farmers' Bulletin 304, B. P. I. Circulars 33, 56, and 112, B. P. I. Bulletins 121, part 4, and 271, and Department Bulletin 282. The hop-improvement studies have made it possible to outline a practical improvement in field methods, resulting in substantial gains in production, while progress toward the establishment of rational and uniform standards of hop valuation has resulted from the laboratory studies of hop constituents.*Assignment.*—W. W. Stockberger, James Thompson, G. A. Russell.*Proposed expenditures, 1916-17.*—\$2,800.**Red-Pepper Cultivation:***Object.*—The introduction of an industry in the culture of red peppers for the spice markets.*Procedure.*—Cultural tests of red-pepper varieties are made with reference to yield, disease resistance, quality of product, etc., and experiments conducted dealing with special methods required in growing, handling, curing, and marketing this crop.*Cooperation.*—Practical farmers.*Location.*—South Carolina.*Date begun.*—1908.*Results.*—Data on paprika culture published in Department Bulletin 43. The successful introduction of paprika culture indicates the possibility of the profitable introduction of the hotter cayenne varieties of red pepper.*Probable date of completion.*—The work on the paprika type of peppers is completed and the crop established; experiments with the hotter varieties of red pepper will probably be completed in 1920.*Assignment.*—T. B. Young.*Proposed expenditures, 1916-17.*—\$1,700.

(Tea Cultivation and Manufacture: The results of these investigations, which have been published in Bureau of Plant Industry Bulletin 234, show that the production of tea is a commercial possibility in South Carolina. Following this successful demonstration, the department's active participation in the project has been withdrawn, and for the present fiscal year no further expenditure of funds in tea investigations is contemplated. There still remains in the hands of the department some special machinery suitable only for tea manufacture, which it is proposed to loan to parties who contemplate continuing efforts to develop tea production on a commercial scale.)

Ginger-Growing Investigations:

Object.—To study the propagation, handling, curing, and testing of varieties of ginger and to determine the possibilities of establishing the production of ginger on a commercial scale in the United States.

Procedure.—Varieties of ginger are tested and their cultural requirements determined. Methods of propagation, handling, curing, and preparation for market are being worked out.

Location.—Orlando, Fla.

Date begun.—1916 as a separate project; preliminary cultural studies have been in progress for several years.

Results.—A number of varieties have been tested and observations made on their adaptability to conditions in the southeastern United States.

Probable date of completion.—1921.

Assignment.—G. A. Russell.

Proposed expenditures, 1916-17.—\$200.

Investigations of Plants Yielding Tannins and Dyes:

Object.—To investigate the value and suitability for commercial use of plants yielding tannins and dyes; to determine what plants may be collected or grown successfully in the United States and profitably utilized as sources of tannins and dyes.

Procedure.—Information regarding the different plants yielding tannins and dyes is accumulated and indexed. Tests of plant materials are made in cooperation with practical tanners and dye manufacturers; cultural trials are made with certain species to determine the possibilities for their commercial production.

Location.—Washington, D. C., and various States.

Date begun.—1908. The investigations on tannins and dyes were separate projects until 1912, when they were included in the work under the project "Miscellaneous Field and Laboratory Work on Drug and Related Plants."

Results.—Data have been accumulated and much information disseminated regarding sources, methods of production and handling, value, and future possibilities of numerous tannin and dye plants.

Assignment.—W. W. Stockberger.

Proposed expenditures, 1916-17.—\$300.

Collection of Information on the Production and Uses of Drug and Related Plants:

Object.—To assemble information relating to the production and uses of drug and related plants, with special reference to sources, collection or cultivation, preparation, etc., as well as to cultural range and commercial production.

Procedure.—Data are secured through correspondence, reference to books and serial literature, and from small experimental cultures at Arlington Farm, Va., and elsewhere in the United States.

Cooperation.—Correspondents, farmers, schools of pharmacy, periodicals, and dealers.

Location.—Washington, D. C., and various points throughout the United States.

Date begun.—1913.

Results.—Much information has been indexed and abstracted and numerous circular letters prepared. Farmers' Bulletin 663, "Drug Plants under Cultivation," has been published.

Assignment.—W. W. Stockberger.

Proposed expenditures, 1916-17.—\$1,025.

Miscellaneous Field and Laboratory Work on Drug and Related Plants:

Object.—This project covers a large number of preliminary investigations and minor problems, including a study of small experimental cultures of numerous drug and related plants and miscellaneous laboratory studies dealing with the value and utilization of the products.

Miscellaneous Field and Laboratory Work on Drug and Related Plants—Continued.

Procedure.—Small experimental cultures of drug and related plants are maintained at testing stations. In general, these tests comprise preliminary trials, which require careful attention in the field and collaboration with laboratory assistants. A variety of laboratory problems not having project rank, involving technical studies of drug and related plants, are worked out.

Cooperation.—University of Wisconsin, at Madison, Wis.; R. S. Hepburn, Timmons ville, S. C.; and Orange County Fair Association, Orlando, Fla.

Location.—Washington, D. C., Arlington Farm, Va., Glenn Dale, Md., Timmons ville, S. C., Madison and Fond du Lac, Wis., and Orlando, Fla.

Date begun.—1902.

Results.—As a feature of the work at Arlington Farm, Va., permanent plantings are being made, which will furnish greatly needed authentic material for standardizing crude drugs. At Glenn Dale, Md., the adaptability of sandy loam has been satisfactorily tested and plantings made on a scale sufficiently large to afford data of commercial value.

Assignment.—W. W. Stockberger, Thos. B. Young, A. F. Sievers, G. A. Russell.

Proposed expenditures, 1916-17.—\$5,040.

Total, Drug and Related Plants and Their Products, \$27,855, including \$3,735 statutory.

POISONOUS-PLANT INVESTIGATIONS.**Geographical Distribution and Localization of Poisonous Plants:**

Object.—To study the geographical distribution and localization of poisonous plants, with special reference to those areas in which, owing to their abundance or concentration, they are believed to be especially harmful.

Procedure.—Botanical reconnaissances are made in areas where harmful plants are believed to be present, suspected plants collected for identification, and the distribution and abundance of those believed to be poisonous plotted.

Cooperation.—Bureau of Animal Industry.

Location.—Washington, D. C., and various other points.

Date begun.—1915.

Assignment.—W. W. Stockberger, W. W. Eggleston.

Proposed expenditures, 1916-17.—\$2,254.

Miscellaneous Studies of Poisonous Plants:

Object.—To study poisonous plants with reference to the nature and pharmacological action of their constituents, methods of eradication, means of avoiding plants harmful to man, etc.

Procedure.—The work involves field and laboratory studies of suspected plants.

Location.—Washington, D. C.

Date begun.—1915.

Assignment.—W. W. Stockberger, A. F. Sievers.

Proposed expenditures, 1916-17.—\$246.

Total, Poisonous-Plant Investigations, \$2,500.

INVESTIGATIONS IN PLANT PHYSIOLOGY AND FERMENTATION.**Physiological Action of Solutions of Organic and of Inorganic Substances on Crop Plants:**

Object.—To ascertain the fundamental requirements made by plants upon the medium in which they live.

Procedure.—Studies are made of the function and growth of crop plants in water cultures and sand cultures made up with mixed solutions of organic and inorganic materials the action of which on plant growth is to be determined. The work is carried on under carefully controlled physiological conditions through the use of laboratory and greenhouse methods.

Location.—Washington, D. C.

Date begun.—1908.

Results.—During the past year the work on the chemical requirements of plants has been extended to include additional types in the hope of ascertaining in how far the results noted are general to crop plants. The work to date has shown: (1) That distilled water and solutions lacking calcium cause a loss of salts by plants, absorption not being sufficient to equal this loss. When the necessary amount of calcium is added, absorption is rapid and salts already in the plant are retained. (2) That the soil solution, in order to support normal

Physiological Action of Solutions of Organic and of Inorganic Substances on Crop Plants—Continued.

life, must contain in proper proportions certain well-known inorganic salts characteristic of fertilizers. When the proper balance is not found in the soil solution the plant behaves abnormally or dies. Results published in Bureau of Plant Industry Bulletin 231 and in six technical papers disseminated through scientific periodicals.

Assignment.—R. H. True, R. B. Harvey.

Proposed expenditures, 1916-17.—\$3,275.

Physiological Study of Injury to Plants by Low Temperatures:

Object.—To ascertain the fundamental nature of the changes produced by low temperatures in plants, and to learn the causes of hardening off and of susceptibility to frost; also to ascertain the nature of the changes taking place in the hardening off of plants.

Procedure.—This project includes a study of injury to plants by low temperatures following different types of preparatory treatment, such as preliminary hardening off and treatment with various types of fertilizer mixtures. Plants are exposed to various degrees of cold and biochemical studies made of the constitution and concentration of their juices, as well as microscopical studies of the plant tissues. It is hoped that as a result of these studies light may be thrown on the cause of injury and means discovered by which such injury may be reduced.

Location.—Washington, D. C.

Date begun.—1916.

Results.—Organization of experiments in progress.

Assignment.—R. H. True, R. B. Harvey.

Proposed expenditures, 1916-17.—\$1,225.

Physiological Study of the Effects of Storage on Fruits and Vegetables:

Object.—To study the physiological behavior of sweet potatoes, onions, and other vegetables, also fruits, during storage under various conditions, with the view of determining the reason for physiological weaknesses developed during and after storage.

Procedure.—Vegetables and fruits are stored at various temperatures for various lengths of time, and biochemical and physiological studies are made of samples of the material taken at different stages of the experiments, in the hope of learning what changes take place during storage and with what result. These investigations are supplemented by field observation and microscopic study.

Location.—Washington, D. C.

Date begun.—1909.

Results.—Investigations previous to 1915 have shown that the sweet potato contains practically no sugar while growing in the ground, the reserve material being almost wholly in the form of starch. During storage at 50°-60° F. a rapid transformation of starch to cane sugar, with the formation of some glucose, takes place, the maximum cane-sugar content being about 7 per cent. At 38°-40° F. the cane-sugar content rises much higher, but the potatoes then become susceptible to the attack of organisms and decay. In the destruction of reserve material by respiration only the starch and glucose are affected, the cane sugar being relatively stable. Results published in Journal of Agricultural Research, vol. 3, No. 4, and vol. 5, Nos. 12 and 13. During the past year the effect of absence of oxygen and of various oxygen pressures on the carbohydrate metabolism of the sweet potato was investigated. As this work is now in progress the results are not yet available.

Assignment.—H. Hasselbring.

Proposed expenditures, 1916-17.—\$3,140.

Physiological Study of the Relation of Oxidizing Enzymes to Plant Diseases:

Object.—To devise a practical method of ascertaining variation in oxidase content in normal and diseased plants, and to investigate the relation of oxidase action to certain important plant diseases.

Procedure.—Methods and apparatus for determining oxidase action are devised, and by means of these investigations in the field and laboratory of oxidase action in normal and diseased plants are made.

Location.—Washington, D. C.

Date begun.—1909.

Results.—The work of the past year has to a considerable extent dealt with the distribution of oxidases in normal plants under various conditions, and, through cooperation with the Minnesota Experiment Station, has included a study

Physiological Study of the Relation of Oxidizing Enzymes to Plant Diseases—Continued.

of the relation of the intensity of oxidase reaction to physiological disturbances brought about by fumigating with hydrocyanic-acid gas. The results of these investigations were published in scientific periodicals under the titles "The Mode of Action of the Oxidases" and "The Relative Oxidases Activity of Different Organs of the Same Plant." The work prior to 1916 has resulted in the development of a new and important method of measuring oxidase action, making it possible to investigate the significance of the oxidase enzymes in normal and diseased plants. Results published in B. P. I. Bulletins 238 and 277, Journal of Agricultural Research, vol. 2, No. 5, and technical papers in scientific periodicals.

Probable date of completion.—1917.

Assignment.—H. H. Bunzell.

Proposed expenditures, 1916-17.—\$2,340.

Physiological Study of Molds and Their Relation to the Deterioration of Plant Products:

Object.—To investigate the physiology of molds with special reference to the products of their metabolism, with the view of determining their conditions of life and the effect of the products which they elaborate.

Procedure.—Molds concerned in the deterioration of seeds, grains, and other plant products are cultivated in pure cultures and in culture media composed of these plant products. A study is made of the products of the activity of these organisms with reference to their chemical and physiological properties, possible toxicity, etc., and of plant products from ordinary sources with reference to the presence of these substances.

Location.—Washington, D. C.

Date begun.—1909.

Results.—A method of determining the degree of deterioration in corn by the acidity test has been devised and is now generally adopted by health boards, corporations, and by the Office of Grain Standardization of the Bureau of Plant Industry. The action of molds growing on spoiled corn has been studied with special reference to the development of toxic substances, and a toxic product has been isolated from cultures of *Penicillium puberulum*. Results published in B. P. I. Bulletins 199 and 270.

Probable date of completion.—1917.

Assignment.—O. F. Black

Proposed expenditures, 1916-17.—\$900.

Physiological Study of Plant Parasites, Especially in Relation to the Plant Attacked:

Object.—To investigate the physiology of parasitic organisms with special reference to the products of their metabolism, their mode of attack, and the physiological results produced in the plants attacked by them.

Procedure.—The parasitic organisms concerned are cultivated in the laboratory, and the biochemical changes produced in culture media and in host plants by these organisms are studied. A study is made of the enzymes produced, the toxic substances formed, and the effect produced on the behavior of the host plant as seen in its modified chemical constituents. The work is carried on in cooperation with the Offices of Cotton, Truck, and Forage-Crop Disease Investigations, Fruit-Disease Investigations, and Forest Pathology, of this bureau.

Location.—Washington, D. C., supplemented by field studies at other points.

Date begun.—1914.

Results.—Chemical studies have been carried on during the past year on the effect of certain parasitic fungi on their host plants. It has been shown that some substances are utilized while others are not. As an example, the starch of potato is not broken down by certain tuber-rotting fungi, while the sugar is all used. The presence of various enzymes in parasitic fungi has been demonstrated. The coloring matter of the chestnut-blight fungus and related fungi has been isolated and studied. The potato leak, a tuber rot of considerable importance in the San Joaquin Valley, Cal., has been investigated, its cause determined, and preliminary methods for its control carried out. Biochemical studies on the tuber rots of potatoes, certain wood-destroying fungi, and certain diseases of strawberries are being carried on. A method of fumigating seed has been devised, in cooperation with the Federal Horticultural Board, and published in Department Bulletin 186. Results of investigations dealing with the effect of certain species of *Fusarium* on the composition of the potato

Physiological Study of Plant Parasites, Especially in Relation to the Plant Attacked—Continued.

tuber and with the leak disease of potato have been submitted for publication, and papers on the utilization of certain pentoses and compounds of pentoses by *Glomerella cingulata* and on some effects of the brown-rot fungus have been published in scientific periodicals.

Assignment.—Lon A. Hawkins.

Proposed expenditures, 1916-17.—\$2,340.

Physiological Study of the Chestnut Tree and Other Plants:

Object.—To determine the nature of physiological changes produced in the chestnut tree and in spinach and other plants as a result of diseased conditions, in the hope of finding means of combating the diseases.

Procedure.—Physiological and biochemical studies of normal and diseased plants are carried on.

Location.—Washington, D. C., Norfolk, Va., and other points.

Date begun.—1915.

Results.—Studies of the organic and inorganic constituents of normal and diseased chestnut bark have been carried out. Factors of error in current methods of determining phosphorus, as well as other problems encountered in estimating certain constituents important in plant metabolism and occurring in minute amounts in the plant materials under investigation, have necessitated preliminary work in the improvement of microchemical and microbiological methods. The results of these studies have been disseminated through seven technical papers published in scientific periodicals.

Assignment.—S. L. Jodidi, E. H. Kellogg.

Proposed expenditures, 1916-17.—\$3,900.

Physiological Study of Germination:

Object.—To investigate the fundamental physiology of the germination of seeds, tubers, and other reproductive plant structures.

Procedure.—Seeds, bulbs, tubers, etc., are studied before, during, and after germination under various chemical and physical conditions under careful laboratory control, and tests are made of enzyme activities in seeds and seedlings. These experiments are conducted in cooperation with the Seed-Testing Laboratory of the Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1915.

Results.—A study of conditions affecting the germination of seeds of the type of Johnson grass has shown that the seed coats are of great importance in regulating the process of germination.

Assignment.—William Crocker, George T. Harrington (Seed-Testing Laboratory).

Proposed expenditures, 1916-17.—\$2,050.

Study of the Ash Constituents of Spinach and Other Plants in Relation to Conditions of Disease:

Object.—To ascertain the modifications in metabolism of spinach and other plants arising in conditions of disease, including the utilization by the plants of fertilizer constituents under a variety of field conditions, with the view of remedying abnormal physiological conditions by the use of plant nutrients.

Procedure.—The work under this project involves the cultivation of spinach and other plants subject to physiological diseases under conditions likely to produce them and a study of the effect of a modification of the nutrition of these plants with reference to the removal of the cause of the trouble. These investigations deal with a series of abnormal conditions which are known as physiological diseases and are frequently supposed to be due to faulty nutrition. The plant materials grown under these various experimental conditions are subjected to a thorough biochemical study in the laboratory in the hope of finding out in what ways the processes of the plants are interfered with by conditions producing disease. The work is carried on in cooperation with the Office of Cotton, Truck, and Forage-Crop Disease Investigations of the Bureau of Plant Industry.

Location.—Washington, D. C., and Norfolk, Va.

Cooperation.—Virginia Truck Crop Experiment Station, Norfolk, Va.

Date begun.—1915.

Results.—Organization of experiments in progress.

Assignment.—R. H. True, O. F. Black.

Proposed expenditures, 1916-17.—\$2,712.

Miscellaneous Investigations in Plant Physiology and Fermentation:

Object.—To handle miscellaneous minor problems arising in the conduct of general plant physiological and fermentation investigations.

Procedure.—Investigations are carried on in the laboratory, field, and greenhouse by specialists, using technical methods. Preliminary investigations conducted here lead to the submittal of definite projects where the problems concerned prove to be of project rank.

Location.—Washington, D. C.

Date begun.—1909.

Results.—During the past year investigations of pigments of fruits, vegetables, and other plant products have been carried on in cooperation with the Office of Pomological and Horticultural Investigations. An investigation of the acid flavor of the dasheen, conducted in cooperation with the Office of Foreign Seed and Plant Introduction, has shown the cause of the acidity to lie wholly in bundles of needlelike crystals of calcium oxalate, known as raphides, which are contained in the skin of the tuberous portion of the plant and more abundantly in the leaves. Studies of the distribution of cyanogen in grasses, etc., and in lablab and various other beans have been carried out and the results published. Results of miscellaneous investigations conducted under this project in previous years have been published in Department Bulletin 109, "The Molds of Cigars and Their Prevention;" Department Bulletin 182, "Agricultural Alcohol: Studies of Its Manufacture in Germany," and 12 papers in scientific periodicals dealing with heredity and variation in plants.

Assignment.—R. H. True, O. F. Black.

Proposed expenditures, 1916-17.—\$2,554.

Total, Investigations in Plant Physiology and Fermentation, \$24,426, including \$900 statutory.

Total, Drug-Plant, Poisonous-Plant, Physiological, and Fermentation Investigations, \$65,180, including \$11,360 statutory.

[Research.]

AGRICULTURAL TECHNOLOGY INVESTIGATIONS.**Supervision:**

Object.—To conduct administrative work, including routine clerical and laboratory duties.

Location.—Washington, D. C.

Date begun.—1907.

Assignment.—N. A. Cobb, W. E. Chambers, Albert Mann.

Proposed expenditures, 1916-17.—\$6,580.

Free-Living and Plant-Infesting Nematodes:

Object.—To improve the methods of treating crops so as to diminish the losses due to attacks of nematodes, including the technological study of the nematodes themselves, their species, life history, and general economic relationships.

Procedure.—This project involves a study of the nature, distribution, and economic relationships of nematodes parasitic in plants or attacking plants and the application of the knowledge so acquired to the study of their attacks on plants, with the object of lessening the damage caused thereby.

Cooperation.—Individual growers in various States, other officers of the department and other branches of the Government, universities, and State governments.

Location.—Washington, D. C.; practically every State.

Date begun.—1906.

Results.—Studies of the gall worm, *Heterodera radicola*, have been continued. Hundreds of samples of roots of plants have been examined, and evidence is constantly accumulating that this serious pest is much more common in gardens than has hitherto been supposed, especially from the latitude of Washington southward. As a means of combating this pest in vegetable gardens, under certain conditions, a rotation with chickens has been tried out and is now recommended, and a special notice dealing with the subject has been prepared for distribution through the Office of Information.

With the object of ascertaining something definite about the nematode fauna of the soil, arrangements have been made with various experiment stations by which examinations have been made of the soil of plats which have been kept under the same crop for a long period of years. These investigations are progressing favorably.

Free-Living and Plant-Infesting Nematodes—Continued.

From experiments conducted at the Arlington Farm definite information has been obtained with regard to the relationship of certain nematodes to certain soil conditions.

Systematic, quantitative experimental observations on sugar-beet plants and their infestation with *Heterodera Schachtii* have been inaugurated, in cooperation with the Office of Sugar-Beet Investigations, with a view to check up the results of efforts toward the control of that pest. Quantitative samples of soil from infested areas have been examined and the number of nematodes per acre ascertained. Examinations of imported German sugar-beet seed and its contaminations have been continued. Thus far four different species of nematodes have been discovered in this material, in some instances in a living condition, though no living adults, larvæ, or eggs of *H. Schachtii* have thus far been discovered.

Foreign soils imported, or likely to be imported, into this country are constantly being examined, with a view to ascertain new facts with regard to their nematode fauna. The results of these examinations are recorded and, as a rule, transmitted to the officers or correspondents concerned. New species of nematodes have thus been discovered and described and other useful information regarding nematodes obtained.

It has been discovered that not infrequently nematodes are abundant in ensilage. The numbers in which they occur suggest that they may sometimes be an important biological factor in the ensilage. Further investigation is under way.

Observations have been made upon the varieties of hermaphroditism that occur in free-living nematodes, and as a result our knowledge of this subject has been materially extended.

The *Tylenchus dipsaci* (synonym *Tylenchus devastatrix*) has been noted in new localities, and steps have been taken to warn growers of its spread and to outline methods of coping with this pest.

An article entitled "Nematodes and Their Relationships" has been prepared and published in the Department Yearbook for 1914. Copies of this article in separate form have been distributed among colleges and universities of the United States, with the result that several colleges have announced their intention to introduce a special study of nematodes into their zoological courses.

A number of articles have been published in scientific journals, all of which have a more or less distinct economic bearing, and numerous lectures have been delivered on the subject of nematodes and their relationship to agriculture and to mankind.

As fast as definite results are obtained they are made known to other offices, such as the Federal Horticultural Board, offices having plant-introduction functions, and offices that are associated with particular crops.

Assignment.—N. A. Cobb, W. E. Chambers.

Proposed expenditures, 1916-17.—\$7,980.

Fiber Technology:

Object.—The study of fiber, especially cotton fiber, with a view to increase our knowledge of the properties of the fiber from a technological standpoint.

Procedure.—A study is being made of those problems lying between the farmer and the manufacturer which are essentially technological in their nature, problems in which it is necessary that the farmer and the manufacturer should better understand each other's conditions and difficulties, with the view of eliminating as far as possible the unreasonable demands of manufacturers and educating the growers with regard to the qualities of their products which are essential in order that they may have the highest intrinsic value.

Cooperation.—Various State governments, private growers, and manufacturers.

Location.—Washington, D. C.

Date begun.—1915 as a separate project; work along these lines has been going on for some years.

Results.—Numerous experiments have been made with regard to the physical properties of cotton fibers, concerned largely with the length and form of the fibers and the tensile strength and hygroscopic qualities of the fibers, with a special view to establish a clearer understanding of the relationship of the various qualities to the uses to which they are put and of the processes they must undergo in course of manufacture. The results of these experiments have been, to a considerable extent, embodied in addresses to various associations connected with the cotton industry.

Fiber Technology—Continued.

Comparisons of the twist or spirality of various cottons have been made, in order to ascertain whether this property will serve as a basis for distinguishing one cotton from another. It is not an infrequent occurrence to have yarn or fabric submitted with questions along this line. A series of experiments upon a considerable number of cottons of the Egyptian and Sea Island varieties, including cotton crops of different years, shows an excess of left-hand twist in Egyptian and an excess of right-hand twist in Sea Island. While there are marked exceptions to the rule, the results of the experiments justify the use of this test in efforts to distinguish between these two kinds of fiber.

Tests have been carried out upon various portions of individual cotton fibers to show what portions of the fibers are strongest and what portions weakest. It remains to be discovered whether different varieties differ in this respect, though it seems hardly likely that such differences exist.

A considerable number of samples of fibers and fabrics have been submitted to this office for examination and report by growers and manufacturers and by officers of the department. In many such cases the observations undertaken in this office with the view of answering questions or securing information consume a good deal of time.

Assignment.—N. A. Cobb.

Proposed expenditures, 1916-17.—\$6,840.

Agricultural Apparatus:

Object.—To investigate and improve agricultural apparatus, with a view to improved efficiency.

Procedure.—Continuous study is made of current apparatus with reference to its relative and absolute efficiency and with reference to its improvement, and new apparatus is devised that will be more efficient or fill needs at present not filled at all—that is, where work is at present performed by hand or in primitive ways. Machine and carpenter shops are necessary.

Cooperation.—Individual farmers and experts in various States, other officers of the Government, and manufacturers.

Location.—Washington, D. C.

Date begun.—1907.

Results.—The more important results achieved in the past are the following:

A clover-seed harvester has been devised and put into operation in conjunction with the Office of Forage-Crop Investigations.

A machine for trimming bulbs has been invented, patented, and put into successful operation.

Other agricultural apparatus devised includes cotton-picking sleds for cotton-picking experiments, a device to roll cotton samples as the cotton leaves the gin, and a device to hold cotton in cartons while being sewed.

Considerable study and experimental work with regard to cotton ginning and the effect of same on cotton have been undertaken, resulting in some instances in putting into practical effect the ideas that have been thus developed. To a smaller extent this is also true of cotton pickers and cotton presses.

During the past year the activities under this project have been of the usual character, though recently they have been confined more particularly to indoor apparatus. Experiments have been made concerning the possibility of using vacuum bottles for the transportation of precooled nematode material. The catalogue file of the office relating to machinery, agricultural tools, and apparatus has been recently renewed and expanded.

Assignment.—N. A. Cobb, M. L. Harrison.

Proposed expenditures, 1916-17.—\$1,000.

Illustrations:

Object.—The projection of better illustrations at lower cost.

Procedure.—Demonstration of methods of illustration, utilizing special apparatus adapted to the quick and accurate and cheaper production of original illustrations for record and publication. Apparatus has been devised specially to meet the needs of investigators and publishers.

Location.—Washington, D. C.

Date begun.—1907.

Results.—The more important results achieved in the past are improvements in the camera-lucida method of preparing illustrations and the devising of a small photostat, a simple substage centering device, a number of methods of staining to bring out certain chromosome details for the purpose of enabling better illustrations to be prepared, a simple camera for taking photomicrographs, and an improved method of utilizing the typewriter for lettering drawings and graphs.

Illustrations—Continued.

During the past year several improvements in methods of producing illustrations for publication purposes have been effected. These relate to the charting of the outline of elongated flexible objects, a practical and less expensive way of lettering drawings, etc. These methods have been applied in illustrations already published and are, therefore, a matter of record. They are also explained to all inquirers at the office, of whom there are quite a number.

Assignment.—N. A. Cobb, W. E. Chambers.

Proposed expenditures, 1916-17.—\$310.

Solar and Artificial Projection:

Object.—To study and devise projection apparatus for making magnification of microscopic objects and for improving illustrations and making minute measurements.

Procedure.—Experiments are conducted with artificial and solar projection and in methods of preparing illustrations and in making such experiments as are suggested by the exigencies of this office as well as of other offices of the department having projection work to do and illustrations to prepare.

Location.—Washington, D. C.

Date begun.—1907.

Results.—The more important results achieved in the past are the following:

The projector for cotton fibers has been improved in various ways and the tungsten lamps especially adapted thereto.

Improvements have been effected in the map measures used in measuring the projected images, and further improvements have been made in the method of testing map measures and the interest of manufacturers and dealers enlisted in carrying these improvements into practical effect.

Promising results have been obtained from experiments made in the reduction of heat in projection apparatus, with a view to avoid its destructive effects on lantern slides and living objects, as well as from experiments made upon aluminum screens, with the view of making the image as visible from the side of the auditorium as from the center.

During the past year a considerable number of small but useful improvements have been made. The use of immersion lenses as condensers in camera-lucida projection work proves to be entirely satisfactory and is the best method yet tried. By this method certain results are obtainable that have not been found obtainable by any other method. New screens for camera-lucida projection work have been tried and improvements introduced. A description of a number of these improvements, together with a complete and detailed description of the microscope installations used in this office, has been published during the year. This publication was made in response to numerous requests for something of the kind, preferred by the leading executive officers of some of the best-known American scientific societies.

Assignment.—N. A. Cobb.

Proposed expenditures, 1916-17.—\$310.

Study of Hawaiian Fungi Other than Cane:

Object.—To collect and study Hawaiian fungi other than cane, and to publish the results of this reconnaissance.

Procedure.—Fungi are collected and studied with the assistance, in the matter of collection, of the various Hawaiian experiment stations.

Cooperation.—States Relations Service, the Hawaiian Sugar Planters' Association, and various Hawaiian experimental stations.

Location.—Washington, D. C.

Date begun.—1906.

Results.—The only result yet obtained comes from a reexamination of a large amount of material bearing upon this investigation, indicating clearly the necessity for the research suggested along these lines.

Probable date of completion.—Should be completed within two years.

Assignment.—N. A. Cobb, E. G. Arzberger, Flora W. Patterson.

Proposed expenditures, 1916-17.—\$500.

Miscellaneous Biological Technology:

Object.—The performance of the large amount of work of a technological nature which this office is called upon to perform for other officers of the Government and which does not properly come under any of the heads of its other projects.

Miscellaneous Biological Technology—Continued.

Procedure.—The work is of a very miscellaneous character. In the past it has consisted principally of the investigation of diatoms, both recent and fossil, for various departments of the Government; photomicroscopy, especially of plant tissue; examination of microscopes and other optical instruments, in consultation with other officers of the Government service who wished advice in the purchase of such apparatus; and special preparation of material for microscopic study, especially in plant morphology.

Cooperation.—Other offices of the department, the Bureau of Fisheries, and the Geological Survey.

Location.—Washington, D. C.

Date begun.—1915 as a separate project; work of this class has been performed since the establishment of this office in 1907.

Results.—An examination for the Geological Survey of deep-well borings from the Black Rock Desert of Nevada for their diatoms has been completed, as has also work undertaken for the Bureau of Chemistry on a method of counting microbes in canned food. A large amount of work has been performed in the way of photomicroscopy, morphological determinations, and special microscopic examinations for various offices of the Bureau of Plant Industry and other offices of the Government.

Assignment.—Albert Mann.

Proposed expenditures, 1916-17.—\$1,700.

Total, Agricultural Technology Investigations, \$25,220, including \$6,880 statutory.

[Research.]

FIBER-PLANT INVESTIGATIONS.**Sisal, Henequen, and Allied Plants:**

Object.—Increased production of fiber suitable for binder twine.

Procedure.—Information about fiber-producing agaves and furcreas is secured, and, if promising, efforts are made to obtain plants and try them in Porto Rico and Hawaii. Plans are being made to begin work in developing improved varieties of sisal, henequen, and similar hard-fiber plants in cooperation with the Experiment Station at Mayaguez, Porto Rico. Information is obtained by means of personal investigation, correspondence, and publications regarding soils, climate, methods of cultivation, and the market, transportation, and economic conditions under which these plants are cultivated profitably. The information thus acquired is used to encourage the establishment of plantations where the conditions are favorable and to warn would-be investors against wasting money on unprofitable plants or trying to grow plants under impossible conditions.

Cooperation.—Porto Rico Experiment Station and Hawaiian Sisal Co. (Ltd.).

Location.—Washington, D. C., Mayaguez, Porto Rico, and Sisal and Robinson, Hawaii.

Date begun.—1902.

Results.—Eighteen introductions, some of them in quantity, have been made into Porto Rico and 14 into Hawaii. Several different species have been tried in southern Florida and southern Texas. The identity of many different species has been determined and definite information secured regarding special conditions of soil and climate required by the different kinds of plants.

Assignment.—Lyster H. Dewey.

Proposed expenditures, 1916-17.—\$1,000.

Flax Fiber Production:

Object.—To encourage the production of flax fiber in regions in this country adapted to this crop, in order to meet the increasing demand and to prevent waste of capital in impractical schemes; and to bring about production in the United States of supplies of seed of improved fiber types of flax.

Procedure.—The types of flax fiber desired by American spinners are determined by investigation, and, by means of plant breeding, flax plants yielding these desirable types are developed and tried out in cooperation with practical flax growers. Flax-breeding work, together with seed-increase plantings of the most promising types, is being carried on in Michigan. Fiber types of flax seed are being grown at the Minnesota Northwest Experiment Station, Crookston, Minn., to demonstrate that seed of fiber flax may be grown in this country without deterioration. Information regarding the requirements, processes, cost, and probable profits in the cultivation of fiber flax is disseminated by bulletins and correspondence.

Flax Fiber Production—Continued.

Cooperation.—James Livingston Flax Co. (Ltd.), Yale, Mich.; Minnesota Experiment Station, Northwest School and Station; and Oregon Experiment Station.

Location.—Washington, D. C., Yale and Croswell, Mich., Crookston, Minn., and Corvallis, Oreg.

Results.—Definite knowledge has been obtained that fiber types of flax are distinct from the types commonly grown for seed. This information has been disseminated and attention called to the futility of attempting to produce spinning fiber from ordinary seed flax. Improved strains of fiber flax have been developed. Four consecutive generations of fiber flax, beginning with seed grown five generations in the United States, compared each year with seed of direct or recent importation, indicate that, contrary to the generally accepted theory, fiber flax seed may be produced in this country fully equal to that imported.

Assignment.—Frank C. Miles.

Proposed expenditures, 1916-17.—\$3,000.

Hemp Fiber Production:

Object.—To encourage the production of hemp fiber in the United States in regions where the hemp crop promises as good profits as may be obtained from other crops; to develop supplies of American-grown fiber for American spinning mills.

Procedure.—Improved types of hemp are developed by plant breeding. Seed of these improved types are distributed to commercial hemp-seed growers. Methods of preparing hemp fiber are investigated. Information as to the best methods of handling the crop is secured and disseminated. Information about uses of the fiber, qualities desired for particular purposes, supplies, and markets is disseminated.

Cooperation.—Wisconsin Experiment Station; Minnesota Experiment Station, Northwest School and Station; and nearly 40 hemp-seed growers in Kentucky.

Location.—Washington, D. C., Madison and Waupun, Wis., Crookston, Minn., and points near Lexington, Ky.

Date begun.—1902.

Results.—Hemp growing has been established on a commercial basis in Wisconsin. Fully 10 per cent of the fiber crop and more than 70 per cent of the seed crop of 1915 in Kentucky was planted with seed of "Minnesota No. 8," an improved strain sent out from the Office of Fiber-Plant Investigations in 1913. Continued improvements are being secured by methods of plant breeding, and seed of two varieties, "Kymington" and "Chington," were sent out in the spring of 1915 in quantity sufficient to plant more than 200 acres of seed hemp.

Assignment.—Lyster H. Dewey, Frank C. Miles.

Proposed expenditures, 1916-17.—\$3,250.

Ramie Fiber Production:

Object.—To determine whether ramie may be grown successfully and profitably in the United States or its island possessions; to investigate methods of handling the crop and preparing the fiber; to encourage its cultivation, if it can be grown profitably; and to discourage waste of capital in stock-selling schemes or attempts to produce ramie under conditions that have been proven to be impossible.

Procedure.—Information is secured and verified, so far as possible, regarding the cultivation of ramie commercially or experimentally. Small plats are grown for observation, and roots for propagation are furnished to experimenters. Prospective investors are furnished with information as to what has been done. Since the results thus far obtained are negative, this project will be held in abeyance until a more promising method of decortication is devised. Investigations, confined chiefly to correspondence, will be continued, in order to secure all available information.

Location.—Washington, D. C.

Date begun.—1890.

Results.—Definite data secured regarding conditions of soil and climate required for successful growth of ramie; one highly recommended decorticating machine found in demonstration to be impractical; many false statements of enthusiastic promoters controverted and would-be investors saved from wasting money.

Assignment.—Lyster H. Dewey.

Proposed expenditures, 1916-17.—\$100.

Improved Teazel Production:

Object.—To develop a variety of teazels adapted to American conditions of cultivation which produce burs of the quality and character of imported French teazels, at present very difficult to obtain; to try to produce in this country a supply of teazels of the desired quality for American woolen mills.

Procedure.—Plants from French teazel seed are being grown and will be tried under different conditions of soil and climate, and seed for further sowing will be saved from selected plants.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Information has been collected and a bed of seedlings started.

Probable date of completion.—About 1921.

Assignment.—Lyster H. Dewey, Frank C. Miles.

Proposed expenditures, 1916-17.—\$400.

Miscellaneous Fiber Investigations:

Object.—To collect, record, and disseminate information about all kinds of plant fibers, except cotton, used for textiles, stuffing brushes, and coarse weaving; to identify fiber plants and plant fibers; to conduct experiments in cultivating some of the more promising fiber plants.

Procedure.—Information is secured from literature, periodicals, correspondence, and personal observation and filed for ready reference. Some of the more promising plants are grown at Arlington Farm, Va., and some tropical ones in Porto Rico.

Location.—Washington, D. C.

Date begun.—1890.

Results.—More than 2,000 letters asking about fiber plants of minor importance are answered each year. Kapok has been introduced into Porto Rico, where it gives promise as a secondary crop.

Assignment.—Lyster H. Dewey.

Proposed expenditures, 1916-17.—\$2,080.

Total, Fiber-Plant Investigations, \$9,830, including \$2,400 statutory.

[Research.]

GRAIN-STANDARDIZATION AND GRAIN-HANDLING AND TRANSPORTATION INVESTIGATIONS.

(See "Enforcement of the United States Grain-Standards Act," p. 464.)

[Research.]

BIOPHYSICAL INVESTIGATIONS.**Supervision:**

Object.—General supervision of biophysical investigations, preparation of data for publication, and the conduct of clerical routine.

Location.—Washington, D. C.

Date begun.—1906.

Assignment.—L. J. Briggs, J. O. Belz.

Proposed expenditures, 1916-17.—\$8,380.

Cooperative Biophysical Investigations:

Object.—To determine the effect of various methods of soil preparation and crop rotation upon the moisture content, temperature, humus content, soluble-salt content, aeration, and other physical properties of the soil, and to provide data for a comparison of the soil and climatic conditions at the various stations in relation to crop productions; also to determine by means of field and pot cultures the water requirement of the principal crop plants grown on the various reclamation projects, with a view to develop a more efficient use of water in irrigated regions.

Procedure.—This work involves the systematic measurement of the soil moisture and climatic conditions at the various stations where field work is being conducted by the Offices of Dry-Land Agriculture Investigations, Western Irrigation Agriculture Investigations, Cereal Investigations, Forage-Crop Investigations, and Alkali and Drought Resistant Plant Investigations, all of the Bureau of Plant Industry. The Office of Biophysical Investigations outlines the method of procedure, provides the apparatus and equipment, supervises

Cooperative Biophysical Investigations—Continued.

the observations, and assists in reducing the results. The field observations are for the most part made by the field staff of the cooperating offices. Special investigations are conducted in cooperation with the Office of Alkali and Drought Resistant Plant Investigations to determine the amount of water required by different crops for the production of a pound of dry matter and the effect of climatic conditions upon such water requirement.

It is also proposed during the coming year to study the moisture content of the soils of the experimental farms located on the reclamation projects with the view of determining the amount of water actually required in crop production under field conditions. These field measurements will also be supplemented by pot cultures.

Location.—Yuma, Ariz., Biggs, Cal., Akron, Colo., Aberdeen, Idaho, Colby, Garden City, and Hays, Kans., Huntley, Havre, and Judith Basin, Mont., Mitchell and North Platte, Nebr., Fallon, Nev., Tucumcari, N. Mex., Mandan, Dickinson, Williston, and Edgeley, N. Dak., Newell, S. Dak., Burns, Moro, and Umatilla, Oreg., Amarillo, Big Spring, Chillicothe, and Dalhart, Tex., Nephi, Utah, Arlington Farm, Va., Archer and Sheridan, Wyo., Lawton, Okla., and Washington, D. C.

Date begun.—1906.

Results.—The results of these measurements appear in various publications of the offices mentioned, and the climatic measurements are being constantly used in connection with the investigations now in progress on the various experimental farms. The soil-moisture determinations are of especial value in determining the methods of tillage most suitable to the different conditions met with in the Great Plains. The evaporation measurements have also been very helpful in comparing and interpreting the yields obtained at the different stations in the semiarid regions as well as in studying the yields under different systems of cultivation at the same station for a period of years. The water-requirement measurements have shown that plants differ greatly in the amount of water used in the production of a pound of dry plant substance, and different varieties of the same crop often exhibit marked differences in the water requirement. Other things being equal, the crop having the lowest water requirement is the one best adapted to dry-land regions, and the water-requirement measurements afford a means of selecting varieties on the basis of their efficient use of water, a matter of fundamental importance in the development of a permanent agriculture in regions having a limited rainfall.

Assignment.—L. J. Briggs, J. O. Belz, A. B. Campbell, Henry Shattyn, F. M. Eaton.

Proposed expenditures, 1916-17.—\$17,220.

(Electrical Method for Determining Moisture Content of Grain: Project completed. An electrical apparatus has been developed which can be carried from car to car, by means of which the moisture content of the grain can be determined rapidly and with reasonable accuracy. This method is based upon the retardation experienced by an electrical pulse traveling along a wire which is buried in a moist medium. A bulletin is in preparation giving the results of this investigation.)

(Electroculture: Project completed. The results indicate that an electrostatic field has very little influence upon plant growth. In no case has a definite and positive stimulation resulted from the electrical treatment. A bulletin is in preparation giving the results of this investigation.)

Relation of Soil Moisture and Soil Solutions to the Growth of Plants:

Object.—To determine the cause of mottle-leaf, a malnutrition trouble of citrus in California and elsewhere, and to develop cultural and other methods of treatment for bringing about a normal growth. This is a serious problem in certain citrus sections of California and leads to a marked reduction in yield and ultimately to the destruction of the groves.

Procedure.—A field laboratory has been established at Riverside, Cal., which is in the center of the worst mottle-leaf section. Field and laboratory experiments have been actively carried on during the past three years with a view to determine the difference in the soils in the good and poor groves and to test the efficiency of certain remedial measures based upon the laboratory experiments.

Cooperation.—There is no official cooperation on this project, but the California Citrus Experiment Station has afforded every facility for the work within its power and for a time provided laboratory and other facilities until the require-

Relation of Soil Moisture and Soil Solutions to the Growth of Plants—Comments of the work exceeded the space at its disposal. Hearty cooperation has also been given by many of the citrus growers, who are showing the greatest interest in the work.

Location.—Headquarters at Riverside, Cal.; investigations include the whole tributary citrus district.

Date begun.—1912.

Results.—Results indicate that mottle-leaf may be due to a variety of causes but that an important contributing cause is the low humus content of the citrus soils. Experimental groves are already showing a most gratifying improvement from the use of manure or other organic material, especially when applied at a permanent mulch on the surface of an irrigation basin around each tree, all cultivation being eliminated.

Assignment.—L. J. Briggs, C. A. Jensen, J. W. McLane.

Proposed expenditures, 1916-17.—\$12,500.

Total, Biophysical Investigations, \$38,100, including \$5,600 statutory.

SEED-TESTING LABORATORIES.

Supervision:

Object.—To carry on the supervisory and clerical work of the seed-testing laboratories.

Location.—Washington, D. C.

Date begun.—1893.

Assignment.—E. Brown.

Proposed expenditures, 1916-17.—\$8,610 (research, \$8,260; regulation, \$350).

[Research.]

Seed Testing:

Object.—To test for mechanical purity or vitality samples of seed submitted by firms or individuals, and to report to them the results of such tests; to make examination of samples of seeds for the presence of adulterants or dodder; and to make identification of weed seed.

Procedure.—At the request of the sender samples of seed submitted to the laboratory are identified, examined for the presence of adulterants or dodder, or tested for mechanical purity or vitality. Reports are sent giving the results of the examination and other information of value to the man who sows the seed.

Location.—Washington, D. C., Columbia, Mo., Corvallis, Oreg., Lafayette, Ind., Berkeley, Cal., and Baton Rouge, La.

Date begun.—1893.

Results.—During the calendar year 1915, 20,896 samples, exclusive of those connected with projects "Adulterated-Seed Investigations" and "Enforcement of the Seed-Importation Act," were received. As in previous years, these samples have been examined and most of them tested for purity or germination, or both. These samples came from the following sources: Commercial samples from farmers and seedsmen, 14,129; noncommercial samples, including those used in special investigations of this laboratory and in investigational work of other offices of the bureau, 4,988; samples from the Office of Foreign Seed and Plant Introduction and the Office of Seed Distribution, 1,033; and samples of forage-plant seeds from customhouses, 746. As in previous years, an effort has been made to divert to the branch laboratories samples of seeds submitted for purity and germination tests and to devote more of the work of this laboratory to investigational and general work.

Assignment.—E. Brown, W. L. Goss, Emma F. Sirrine.

Proposed expenditures, 1916-17.—\$16,040.

Seed Purity and Vitality Investigations:

Object.—To study the quality of commercial seeds; study crop seeds and the weed seeds found in them with a view to their definite identification; determine the origin of commercial seeds by means of the weed-seed content; collect and distribute authentic seeds for use in identification by comparison; develop improved laboratory methods of testing seeds for vitality; determine the agricultural value of hard seeds; study methods of harvesting, curing, and storing best adapted to preserve vitality; and investigate the physiology and chemistry of seed germination.

Procedure.—Closely related groups of seeds are studied, and the characters by which they can be distinguished are described and illustrated. Weed seeds

Seed Purity and Vitality Investigations—Continued.

found in seeds of foreign origin are studied, described, and illustrated as a means of determining the place of origin of imported seeds. Various kinds of commercial seeds are examined from time to time, and publications are issued calling attention to any unusual conditions of quality or origin. Weed seeds and economic seeds are put up in sets and sent to schools and individuals on payment for the containers. The physiology and chemistry involved in the germination of Johnson-grass seed is being critically studied in determining the fundamental processes of seed germination.

Location.—Washington, D. C.

Data begun.—1905.

Results.—The distinguishing characters of Johnson-grass and Sudan-grass seed have been worked out and published. Seed imported as rape has been studied, and serious adulterants of winter rape have been found. Some 500 sets of 100 samples each of weed seeds commonly found in commercial seeds have been prepared and distributed. It has been determined that a large part of the so-called hard seeds in legumes will germinate readily if seeded several weeks before the ground is warm enough for germination in the spring, while much of the same seed if planted when the ground is warm will lie dormant in the soil.

Assignment.—F. H. Hillman, G. T. Harrington.

Proposed expenditures, 1916-17.—\$6,140.

Adulterated-Seed Investigations:

Object.—To publish information as to the extent of the sale of adulterated or misbranded forage-plant seeds, including the analyses of such seeds, with the names and addresses of the dealers selling them.

Procedure.—Each year about 50 agents of the department are appointed who as individuals purchase seeds in the usual course of the trade. These samples are analyzed and, when found to be adulterated or misbranded, the analyses, together with the names and addresses of the persons or firms selling the seeds, are published.

Location.—Washington, D. C.

Date begun.—1904.

Results.—During the calendar year 1915 1,552 samples of seed of Sudan grass, redtop, and rape were collected. The redtop seed was found to be badly adulterated with timothy, no doubt due largely to the unusual profit resulting from the sale of timothy seed as redtop seed. The Sudan-grass seed was examined for adulteration with Johnson-grass seed, but no cases of adulteration were found. A number of lots of adulterated or misbranded rape seed were found.

Proposed expenditures, 1916-17.—\$5,510.

[Regulation.]**Enforcement of the Seed-Importation Act:**

Object.—The enforcement of the seed-importation act of August 24, 1912, the object of this act being to prohibit the importation into the United States of certain specified seeds when adulterated or unfit for seeding purposes.

Procedure.—All lots of imported forage-plant seeds specified in the act are sampled by customs officers and the samples forwarded to the nearest district seed-testing laboratory. The samples are examined and the customs officers directed to release or refuse delivery of the shipment according to whether it does or does not conform to the requirements of the act.

Location.—Washington, D. C.

Date begun.—1913.

Results.—During the past year samples of 1,264 lots of imported seeds subject to the seed-importation act were examined and 67 lots were prohibited entry. Of those prohibited entry 16 lots were exported, 41 lots were permitted entry after recleaning, 6 lots were permitted entry without recleaning, and 4 lots are awaiting disposition.

Of the refuse made up largely of weed seeds removed from the 41 lots recleaned 59,036 pounds were exported or destroyed and 22,978 pounds are awaiting disposal.

Assignment.—E. Brown.

Proposed expenditures, 1916-17.—\$4,600.

Total, Seed-Testing Laboratories, \$40,900, including \$9,200 statutory (research, \$35,950; regulation, \$4,950).

[Research.]

CEREAL INVESTIGATIONS.

SUPERVISION.

Supervision:

Object.—To direct field investigations and laboratory studies, and to supervise clerical work, including correspondence, preparation of manuscripts and reports, financial records, maintenance of property and supplies, preparation of photographic material, maintenance of miscellaneous files and herbaria, seed distribution, and the general details connected with the field and laboratory investigations.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—M. A. Carleton.

Proposed expenditures, 1916-17.—\$20,253, including \$13,020 statutory.

PRODUCTION AND IMPROVEMENT OF CEREALS AND CEREAL PRODUCTS

Wheat Investigations:

Object.—To determine varietal adaptations and the factors influencing them; improve the crop through selections and hybridization of varieties and races; study and improve production methods; study inheritance in hybrids; and identify, describe, and classify varieties.

Procedure.—Varieties and races are tested on replicated field plats to determine yielding power, adaptation, and proper dates, rates, depths, and methods of seeding. Selections of promising individuals are made and compared and the best increased. Crosses are made to combine desirable characters and to study the phenomena of inheritance. All available domestic and foreign varieties and strains are obtained, grown in nurseries, studied, preserved in herbaria, described, and classified.

Cooperation.—State experiment stations in Georgia, Idaho, Iowa, Kansas, Maryland, Minnesota, Missouri, Montana, New York (Cornell), North Carolina, North Dakota, Oregon, South Dakota, Utah, and Washington, Amarillo (Tex.) Board of City Development, and Wyoming Board of Farm Commissioners.

Location.—Chico, Cal., Akron, Colo., Ashburn, Athens, and Quitman, Ga., Aberdeen, Idaho, Ames, Iowa, Hays and Manhattan, Kans., College Park, Md., St. Paul, Minn., Columbia, Mo., Moccasin, Mont., Ithaca, N. Y., Raleigh, Statesville, and Swannanoa, N. C., Dickinson and Williston, N. Dak., Burns and Moro, Oreg., Brookings, Cottonwood, Highmore, and Newell, S. Dak., Amarillo, Tex., Nephi, Utah, Arlington Farm, Va., Lind, Wash., and Archer, Wyo.

Date begun.—1890.

Results.—Results published in B. P. I. Circulars 12, 59, 61, and 79, B. P. I. Bulletins 3, 70, 178, 240, 269, and 283, Department Yearbook Separates 195, 511, and 649, Department Bulletins 30, 33, 39, 157, 270, 297, 336, and 357, and Farmers' Bulletins 139, 466, 534, 596, 616, 678, and 680. The varieties of high quality which are the best average yielders under varying seasonal conditions have been determined for an increasing number of districts. These results either have been published or are being prepared for publication. Directions for growing eastern winter wheats and hard spring common and durum wheats have been published. Valuable strains of Arnautka, Chul, Ghirka, Kubanka, and other varieties have been bred at field stations. Bulletins on Ghirka Spring wheat and Marquis wheat are in press. Hundreds of varieties and strains have been assembled for identification and classification. About 3,500 separate sowings of these were made in the fall of 1915 and spring of 1916.

Assignment.—C. R. Ball, C. E. Leighty, J. A. Clark.

Proposed expenditures, 1916-17.—\$32,429.

Oat Investigations:

Object.—The improvement of oats by a study of production methods, the breeding of new varieties, and the extension of the winter-oat area.

Procedure.—Extensive varietal tests are conducted. New varieties and selections are being produced by the pure-line method from the better commercial varieties and from hybrids of spring and winter oats. A study of cultivated varieties and of closely allied species preliminary to the classification and description of all American varieties of oats is in progress. Experiments in production methods are conducted, and a study is also made of the methods employed by the best farmers.

Oat Investigations—Continued.

Cooperation.—State experiment stations in Georgia, Idaho, Iowa, Kansas, Maryland, Montana, Nebraska, New York (Cornell), North Carolina, North Dakota, Oregon, South Dakota, Utah, and Washington, Amarillo (Tex.) Board of City Development, and Wyoming Board of Farm Commissioners.

Location.—Chico, Cal., Akron, Colo., Ashburn, Athens, and Quitman, Ga., Aberdeen, Idaho, Ames, Iowa, Hays and Manhattan, Kans., College Park, Md., Moccasin, Mont., Lincoln, Nebr., Ithaca, N. Y., Raleigh, Statesville, and Swannanoa, N. C., Dickinson and Williston, N. Dak., Burns and Moro, Oreg., Brookings, Cottonwood, Highmore, and Newell, S. Dak., Amarillo, Tex., Nephi, Utah, Arlington Farm, Va., Lind, Wash., and Archer, Wyo.

Date begun.—1902.

Results.—Data given in Farmers' Bulletins 395, 420, 424, and 436, B. P. I. Bulletins 182, 240, and 283, B. P. I. Circulars 12, 30, 59, and 61, and Department Bulletins 30, 33, 39, 99, 297, and 336. New varieties of spring oats have been distributed through the Cornell University and the Iowa experiment stations and selected stocks of winter oats from the Arlington Farm. The best varieties for numerous sections have been determined by varietal tests, and the results have been published or are in preparation for publication. Several hundred varieties have been collected and grown in the classification nursery.

Assignment.—C. W. Warburton, T. R. Stanton.

Proposed expenditures, 1916-17.—\$12,532.

Barley Investigations:

Object.—Production of new varieties by breeding and incidental inheritance studies upon the crosses made; study of the physiology and morphology of the barley grain; study of production methods; extension of the barley-growing areas by the use of new varieties, new importations, and the better utilization of those already at hand; and the agronomic and botanical classification of barley varieties.

Procedure.—Extensive breeding experiments are being carried on for the purpose of producing superior varieties. The products of the principal breeding nurseries—those at Arlington Farm, Va., St. Paul, Minn., Aberdeen, Idaho, and Chico, Cal.—are annually distributed to the areas where they are best suited. Morphological and physiological studies of the grain and plant are being carried out, in order to interpret environmental and cultural effects. The study of the cause of high nitrogen in the barleys of the dry lands is being continued, and it is expected to correlate this behavior with the development of grain under irrigated conditions. The study of production methods is being carried on in certain areas in continuous experiments. Efforts are being made to discover more hardy winter barleys, more drought-resistant summer forms, and more productive types of all kinds. Data are being accumulated upon which to base a classification of the botanical and agricultural varieties of barley. The first is to meet a very persistent demand from agronomists in general, and has been studied incidentally for some time. The second study, which has been carried out a single season, has for its ultimate object the identification and description of all varieties which have been or are in cultivation in America. By this means it is hoped to interpret work which has not realized its full value because of misnamed or unidentified varieties.

Cooperation.—State experiment stations in Georgia, Idaho, Kansas, Minnesota, Montana, New York, North Carolina, North Dakota, Oregon, South Dakota, and Washington, Amarillo (Tex.) Board of City Development, and Wyoming Board of Farm Commissioners.

Location.—Chico, Cal., Akron, Colo., Athens, Ga., Aberdeen, Idaho, Hays, Kans., St. Paul, Minn., Moccasin, Mont., Ithaca, N. Y., Raleigh, N. C., Dickinson and Williston, N. Dak., Burns and Moro, Oreg., Brookings, Cottonwood, Highmore, and Newell, S. Dak., Amarillo, Tex., Nephi, Utah, Arlington Farm, Va., Lind, Wash., and Archer, Wyo.

Date begun.—1902.

Results.—The results of the studies made in barley investigations have been published from time to time in B. P. I. Circulars 5, 61, and 62, B. P. I. Bulletins 240 and 283, Department Bulletins 30, 33, 39, 137, 183, 270, 297, and 336, and Farmers' Bulletins 427, 443, and 518. The Bureau of Plant Industry and department bulletins give the data from experiments at various field stations, consisting largely of yields of varieties and the results of cropping methods. Morphological and physiological studies of grain and plant have already shown why awnless barleys are not suited to humid districts. In one or two instances

Barley Investigations—Continued.

purely technical studies, as of the malting function of the barley grain, or inheritance studies of the breeding nursery, are reported. The farmers' bulletins are concerned with general recommendations as to the best methods of growing barley in one case in the spring-barley areas and in another in the winter-barley areas.

Assignment.—H. V. Harlan, Stephen Anthony.

Proposed expenditures, 1916-17.—\$11,853.

Rice Investigations:

Object.—The improvement of rice by a study of the cultural requirements and varietal adaptations and by selection and breeding.

Procedure.—Rices from foreign countries are introduced and tested for earliness of maturity, quality, and yielding power. From the promising varieties individual plants of the most desirable types are selected. In this way superior types are developed and increased for distribution. Cultural tests are made to determine how yield may be affected by different depths of plowing, different methods of preparing the seed bed, and different rates, depths, and dates of seeding. Various commercial fertilizers are used at different rates to determine their effect on yield. The water requirements of the crop are determined by the application of irrigation water at different depths and dates of submergence, noting the effects of stagnant water as compared with slowly changing water, and no irrigation. The control of weeds is attempted largely through rotations containing cultivated crops. The nursery is used for botanical and hybridization studies.

Cooperation.—Louisiana Experiment Station and Sacramento Valley Grain Association of California.

Location.—Crowley, La., and Biggs, Cal.

Date begun.—1905.

Results.—New varieties have been distributed for commercial plantings; hybrids have been produced that are resistant to the fungous disease *Piricularia oryzae*, commonly known as "rotten neck"; and control of red rice by rotations containing cultivated crops has been demonstrated. The investigations of rice in the Sacramento Valley of California are reported in Bureau of Plant Industry Circular 97. The rice industry in California has been established largely on the basis of these investigations. Farmers' Bulletin 688 deals with the culture of rice in California.

Assignment.—Charles E. Chambliss, J. Mitchell Jenkins, E. L. Adams.

Proposed expenditures, 1916-17.—\$11,323.

Grain-Sorghum and Broom-Corn Investigations:

Object.—To improve varieties by breeding, determine varietal adaptations, extend the producing area, study cultural requirements, determine human-food value of sorghum meal, and promote commercial uses of these crops.

Procedure.—Domestic and foreign varieties and strains are tested on field plats to determine adaptation and yielding power of grain and brush. Selections of promising varieties are made. Proper dates, rates, and methods of seeding, time of harvesting, and methods of curing the brush are studied.

Cooperation.—Experiment stations of Kansas and South Dakota and to a minor extent of other Western States, and Amarillo (Tex.) Board of City Development.

Location.—Biggs, Cal., Akron, Colo., Hays and Garden City, Kans., Woodward, Okla., Moro, Oreg., Highmore and Newell, S. Dak., Amarillo and San Antonio, Tex., and Arlington Farm, Va.

Date begun.—Grain sorghums, 1905; broom corn, 1911.

Results.—Results published in Bureau of Plant Industry Circulars 50 and 122, Bureau of Plant Industry Bulletins 175, 203, 237, 253, and 283, Farmers' Bulletins 322, 448, 552, and 686, and Department Yearbook Separate 625. Nine more varieties of kaoliang were obtained from China and sown in a varietal test. Head selections were made from the most promising ones. Thirty-four lots of commercial broom-corn seed were collected and grown in the classification nursery. Eight lots were found to be badly hybridized. A farmers' bulletin on the growing of dwarf broom corn in the southern plains area is in preparation.

Assignment.—C. R. Ball, B. E. Rothgeb.

Proposed expenditures, 1916-17.—\$6,684.

Flax Investigations:

Object.—Improvement of flax through selection and breeding; introduction and acclimatization of foreign varieties and study of their adaptation to different areas; extension of the flax acreage in the Northwest and development of a winter-flax area in the Southwest; determination of the best cultural and production methods; the obtaining of a knowledge of inheritance in hybrids; and the botanical and agronomic classification of flax varieties.

Procedure.—Heretofore much time has been given to the introduction of a large number of foreign varieties and the distribution of these and the northern-grown strains to more than 30 stations for testing in replicated field plats or nursery rows, in order to determine comparative yielding powers, adaptation, and the proper dates, rates, and methods of seeding. More time is now available for the breeding work. This is chiefly confined to the Northern Great Plains Field Station, Mandan, N. Dak., which is near the present center of flaxseed production. At this station hybrids and selections are made and compared, the best of these being increased and distributed to other stations. In addition, all new introductions will be tested at Mandan before being widely distributed. Studies on the inheritance of characters are being made in connection with the hybrid work, and data are being collected on the varieties and selections for botanical and agronomic classification. At the same time studies on the acclimatization of the varieties to various regions and the relative variability of their different characters to wide extremes of climatic and soil conditions are being carried on. Phases of this line of work are the development of a winter-flax area in the Southwest and the production of varieties suitable to these conditions.

Cooperation.—Experiment stations in Colorado, Idaho, Iowa, Minnesota, Montana, New York (Cornell), North Dakota, Oregon, South Dakota, and Utah, Amarillo (Tex.) Board of City Development, and Wyoming Board of Farm Commissioners.

Location.—Phoenix and Sacaton, Ariz., Bard and Davis, Cal., Akron, Colo., Aberdeen, Idaho, Ames, Iowa, St. Paul, Minn., Havre, Huntley, and Moccasin, Mont., Mitchell, Nebr., Dickinson, Fargo, Mandan, and Williston, N. Dak., Burns and Corvallis, Oreg., Highmore and Newell, S. Dak., San Antonio, Tex., and Archer, Wyo.; minor tests and nursery series at Chico, Cal., Crowley, La., Ithaca, N. Y., Moro, Oreg., Amarillo, Tex., and Nephi, Utah.

Date begun.—1913.

Results.—Data given in manuscript submitted for a farmers' bulletin. Three years' results have been obtained on a uniform series of varieties tested in field plats at a number of stations. Seed samples have been procured and oil analyses made of all of these. A larger series in nursery rows has furnished material for a similar and correlated study. These data are now practically ready for compilation. Hybrid work has been continued at Mandan, N. Dak., and seed of first, second, and third generation hybrids is available for seeding in 1916. More than 1,000 selections were tested at Mandan and Williston, N. Dak., Moccasin, Mont., and other stations in connection with the nursery work in 1915. Several selections made in 1913 are very promising and will be increased in field plats in 1916. Herbarium specimens have been obtained for classification study. As a result of the satisfactory showing made in 1915, the varietal work in the Southwest has been put on a field-plat basis at five stations.

Assignment.—Chas. H. Clark, John C. Brinsmade, jr., Theodore Stoa.

Proposed expenditures, 1916-17.—\$5,207.

Investigations of Minor Cereals:

Object.—The improvement of rye, proso, and buckwheat in yield and quality by means of breeding and the study of cultural methods.

Procedure.—Varietal tests and breeding operations are under way, and a study is being made of the field requirements of the crops. Studies of rye pollination are being conducted.

Cooperation.—State experiment stations of Georgia, Idaho, Iowa, Kansas, Maryland, Minnesota, Missouri, Montana, New York (Cornell), North Carolina, North Dakota, Oregon, South Dakota, and Utah, Amarillo (Tex.) Board of City Development, and Wyoming Board of Farm Commissioners.

Location.—Chico, Cal., Akron, Colo., Ashburn, Athens, and Quitman, Ga., Aberdeen, Idaho, Ames, Iowa, Hays and Manhattan, Kans., College Park, Md., St. Paul, Minn., Columbia, Mo., Moccasin, Mont., Ithaca, N. Y., Statesville, N. C., Dickinson and Williston, N. Dak., Burns and Moro, Oreg., Highmore and Newell, S. Dak., Amarillo, Tex., Arlington Farm, Va., Nephi, Utah, and Archer, Wyo.

Investigations of Minor Cereals—Continued.*Date begun.*—1898.*Results.*—Results proving the cross-fertilization of rye have been obtained, and natural rye-wheat hybrids have been discovered. A manuscript for publication has been prepared on rye. The best varieties of introduced prosos have been determined, these being as follows in order of value: Black Voronezh, Tambov, Red Lump, Orenburg Red, and Turghai.*Assignment.*—M. A. Carleton, C. E. Leighty, C. R. Ball.*Proposed expenditures, 1916-17.*—\$1,854.**Total, Production and Improvement of Cereals and Cereal Products,** \$81,882, including \$3,060 statutory.**MAINTENANCE OF GENERAL CEREAL FIELD STATIONS.****(Cereal Field Stations in Semiarid Regions:** Discontinued as a separate project; work reported under specific investigational projects of this office.)**(Cereal Field Stations in Humid Regions:** Discontinued as a separate project; work reported under specific investigational projects of this office.)**CEREAL AND FLAX TILLAGE AND ROTATION INVESTIGATIONS.****Cereal and Flax Tillage and Rotation Investigations:***Object.*—To improve the yield and quality of cereals and flax through better cultural methods and rotations and to eliminate the necessity for frequent summer fallowing on certain dry lands of the West; to increase the humus content of the soil through rotations with intertilled crops and by green manuring.*Procedure.*—Different methods of preparation of the soil preceding the seeding of grain are tested: Rotations of different leguminous crops, particularly field peas and alfalfa, in alternation with the cereals are conducted at each of the points where work is done. Wherever corn is at all adapted this crop is being used in alternation with grains, in place of summer fallow, for the conservation of moisture. Where corn is not adapted grain sorghums, potatoes, field peas, and other crops are used instead. In the main, the same lines of work will be continued during the present year, but the experiments will be more extended.*Cooperation.*—State experiment stations of Georgia, Idaho, Oregon, Utah, and Washington.*Location.*—Athens, Ga., Aberdeen, Idaho, Burns and Moro, Oreg., Nephi, Utah, and Lind, Wash.*Date begun.*—1904.*Results.*—It has been determined that in some places potatoes do well as an intertilled crop alternating with cereals, but often the extent of potato cultivation is not sufficient to make it important in this respect. Corn and sorghum in rotation have also been effective in conserving moisture for cereal crops, and have besides sometimes yielded some returns themselves. Excellent results from the use of field peas in alternation with cereals have been obtained, particularly in Oregon, causing much better yields of the cereals, besides being profitable in themselves. The effect of green rye or vetch, or both together, plowed under before seeding wheat has also been very great on the following wheat crop. Data in Department Bulletin 157.*Assignment.*—M. A. Carleton, L. C. Aicher, L. R. Breithaupt, R. R. Childs, J. W. Jones, M. A. McCall, D. E. Stephens.*Proposed expenditures, 1916-17.*—\$2,750.

CEREAL-DISEASE INVESTIGATIONS.

Investigations of Cereal Rusts:

Object.—To study the rust resistance of cereals and of wheat in particular; conduct cereal-breeding experiments for the purpose of producing rust-resistant varieties; study the physiology and morphology of cereal rusts and related forms; determine the relation of rusted seed to rust epidemics; obtain data on geographic distribution and spore migration of the rusts; and determine facts concerning distribution of the stripe rust and make a thorough study of this rust in its relation to wheat, barley, rye, and wild grasses.

Procedure.—Greenhouse and nursery cultures of a number of varieties of wheat and other small grains are conducted to determine the relative resistance of each and the relation of growth factors to infection. Extensive hybridization and selection experiments are conducted in the field nursery at St. Paul, Minn. Rust-resistant durum wheats and other resistant varieties are crossed on varieties noted chiefly for milling and bread-making qualities to obtain good all-purpose and rust-resistant strains. The physiology and chemistry of infection are studied to obtain more data on the physiological behavior of host plant and of host tissues when subject to invasion by the rust organism. More precise knowledge of the relation of growth factors will be obtained through the use of radiotmometers and more refined methods of recording relative humidity, soil, and atmospheric temperatures, wind movements, etc. Because of the recent rust epidemic in the Northwest these investigations will be greatly increased and the following additional work will be undertaken: An exhaustive study of the rust-in-seed problem; extensive field observations and studies in North Dakota, South Dakota, Minnesota, Kansas, and wheat-producing sections elsewhere in the United States; a continuation of studies on the relationships of the rusts of grasses to cereal crops, and vice versa; laboratory and greenhouse studies on the water requirements of rust-infected wheat and oat plants of various varieties; and further studies on the cytology of infection.

Cooperation.—State experiment stations of Iowa, Kansas, Minnesota, and Tennessee.

Location.—Washington, D. C., Akron, Colo., Ames, Iowa, Manhattan, Kans., Crookston and St. Paul, Minn., Brookings, S. Dak., and Knoxville, Tenn., and field stations of the Office of Cereal Investigations.

Date begun.—1894.

Results.—Data published in Vegetable Pathology and Physiology Bulletin 16 and Bureau of Plant Industry Bulletins 63, 216, and 224; additional data secured on the question of rust-resistant varieties now in manuscript and about to be submitted for publication as a department bulletin. Considerable work has been done relative to the influence of meteorological factors on the development of rust epidemics. Extensive milling and baking tests have been made with reference to a number of rust-resistant hybrids. A new (to America) rust was discovered in May, 1915, and a bulletin concerning it is now in preparation.

Assignment.—H. B. Humphrey, John H. Parker, C. W. Hungerford.

Proposed expenditures, 1916-17.—\$16,420.

Investigations of the Fungous and Nonparasitic Diseases of Corn, Sorghum, and Broom Corn:

Object.—To investigate the life histories and physiology of the smuts of corn, sorghum, and broom corn and of other fungi known to produce diseases of these crops, devise methods of control, and secure information relative to the geographic distribution and economic importance of these diseases.

Procedure.—Field, laboratory, and greenhouse experiments are now in progress and others are carried on to determine unknown facts concerning the life histories and physiological behavior of hosts to parasites, and *vice versa*. Experiments with various fungicides and sprays are undertaken and studies made of varietal resistance of corn and sorghum to the smuts peculiar to these crops.

Cooperation.—Minnesota and Kansas experiment stations.

Location.—Washington, D. C., Manhattan, Kans., St. Paul, Minn., and Amarillo, Tex.

Date begun.—1906.

Results.—Kernel smut of sorghum has been found to be preventable; data in B. P. I. Circular 8. The life history of head smut of sorghum has been made known and the results published in the Journal of Agricultural Research, vol. 2, No. 5, under the title "Head Smut of Sorghum and Maize"; also a paper in

Investigations of the Fungous and Nonparasitic Diseases of Corn, Sorghum, and Broom Corn—Continued.

Phytopathology, vol. 5, No. 3, under the title "Loose Kernel Smut of Sorghum." Interesting data have been obtained bearing on the method of infection and the physiology of corn smut.

Assignment.—H. B. Humphrey.

Proposed expenditures, 1916-17.—\$10,810.

Investigations of the Smuts of Small Grains:

Object.—To investigate the physiology and distribution of the smuts of small grains, determine incompletely known facts pertaining to their life histories, and improve present methods of smut control and devise new ones.

Procedure.—Bunt or stinking smut: A series of outlined field experiments will be continued to determine the necessary length of rotation period for prevention of bunt in the Pacific Northwest. Further laboratory and field experiments will be conducted to determine accurately the influence of soil moisture and soil temperature on the infection of wheat by the bunt organism, to determine the relation of early and late sowing on infection, to ascertain facts concerning relation of tillage to infection, and to study by chemical analysis the chemistry infection. This will involve an effort to extract the catalytic (or other) enzyme which may be active in assisting infection.

Loose smuts of wheat and barley: There is now being made a careful experimental study of the process of infection, in order that better control of infection may be had in the artificial inoculation of material for microscopic study and that work on the subject of control measures may be facilitated through seed selection. To develop practicable means of control, curves integrating the factors of time and temperature in the death point of cereal seed and of the fungus within the seed are being plotted on the basis of a single prolonged hot-water treatment between 40° and 50° C. These data are to be used in producing a mechanical device that will automatically integrate the two factors. Other methods of prevention are being studied.

Oat smuts: These are being studied with a view to a better understanding of their distinctions in field and artificial cultures and in their life-history characteristics. The application of these results to a critical study of the immunity of Burt oats is projected.

Cooperation.—State experiment stations of Kansas, Minnesota, and Washington.

Location.—Washington, D. C., Manhattan, Kans., St. Paul, Minn., Pullman, Wash., and field stations of the Office of Cereal Investigations.

Date begun.—1890.

Results.—Methods of prevention of bunt or stinking smut of wheat, covered smut of barley, and oat smut worked out; estimated annual preventable loss, \$38,000,000; data in Bureau of Plant Industry Bulletin 152, Department Bulletin 30, and Farmers' Bulletins 219 and 507. Loose smut of rye was discovered in 1913. Flag smut of rye has been found serious in the North-Central States, and it has been shown to be preventable by seed treatment. Additional data have been recorded on the influence of soil temperature and soil moisture on the infection of wheat by the stinking-smut organism, and on crop rotation as a means of controlling stinking smut in the Pacific Northwest.

Assignment.—H. B. Humphrey, A. A. Potter.

Proposed expenditures, 1916-17.—\$2,060.

Miscellaneous Cereal and Flax Diseases:

Object.—To determine the prevalence and economic importance of the disease-producing fungi common to rice and other minor cereal crops and of flax, and to investigate their life histories and methods for their control; to investigate the imperfect fungi known to cause diseases of economic importance in cereals, and to devise methods of control.

Procedure.—Diseases of rice: Carefully conducted field, greenhouse, and laboratory experiments relating to the physiology, life history, and control of the rice-blast organism, *Piricularia grisea*, and several other organisms which are related to seedling blights, leaf diseases, and possibly to straight-head, are made. Comprehensive experiments on the relation of cultural treatments to the probable causes of straight-head are under way.

Diseases of barley: Cooperation will be continued with the Wisconsin Experiment Station on the Helminthosporium diseases of barley. Studies will cover the life histories and habits of the several organisms, cardinal temperatures,

Miscellaneous Cereal and Flax Diseases—Continued.

physiology of infection, methods of control by means of formaldehyde and other fungicides, distribution and economic importance of each of the three diseases, and the relation of the causative organisms to other cereals and to wild and cultivated grasses.

Diseases of other cereals induced by imperfect fungi: Each of several of these fungi isolated from diseased wheat, oats, rye, flax, and buckwheat has been studied with reference to its economic importance and possible relation to several obscure diseases, some of which have been classified as root diseases. Field and laboratory studies will be conducted to determine the cause of flax canker and to determine facts relative to the physiology and etiology of flax wilt.

Cooperation.—State experiment stations of North Dakota and Wisconsin.

Location.—Washington, D. C., Fargo, N. Dak., Madison, Wis., and field stations of the Office of Cereal Investigations.

Date begun.—1904.

Results.—Rice: Two species of *Fusarium* found with considerable constancy in diseased rice plants have been isolated and studied and further data on the physiology of *Piricularia grisea* accumulated. The relation of different organisms to seedling blights has been established. The organism causing a very common leaf disease has been isolated, and studies in its life history are being made. Considerable data bearing upon the apparent influence of cultural treatments on straight-head have been accumulated and utilized in experimental work.

Other cereals: Experimental evidence showing the susceptibility of wheat and oats to infection has been obtained, and species of *Helminthosporium* and *Fusarium* have been isolated from diseased plants received from different parts of the country. A paper entitled "A Study of Some Imperfect Fungi Isolated from Wheat, Oats, and Barley Plants" was published in the *Journal of Agricultural Research*, vol. 1, No. 6, 1914. Stripe disease of barley is found to be largely preventable by formaldehyde treatment.

Assignment.—H. B. Humphrey, G. H. Godfrey.

Proposed expenditures, 1916-17.—\$6,410.

Total, Cereal-Disease Investigations, \$35,700.

Total, Cereal Investigations, \$140,585, including \$16,080 statutory.

[Research.]

CORN INVESTIGATIONS.**Supervision:**

Object.—To supervise the various subactivities under this group and carry on routine office business in connection with corn investigations, including correspondence, maintenance of records, purchase of supplies and equipment, etc.

Location.—Washington, D. C.

Date begun.—1900.

Assignment.—C. P. Hartley, E. B. Brown, J. M. Hammerly.

Proposed expenditures, 1916-17.—\$7,380.

Production of Improved Strains of Corn for the Different Geographical Sections of the United States:

Object.—To determine by investigational work efficient methods of corn breeding and their practical application in the improvement of strains of corn under different environments.

Procedure.—Methods of breeding corn are tested with many strains under different environments and accurate data as to results maintained. Improved seed and suggestions as to corn improvement are placed with farmers throughout the United States.

Cooperation.—Individual farmers.

Location.—Arlington Farm, Occoquan, and Round Hill, Va., Oconomowoc, Wis., Piketon and Sunbury, Ohio, Rhinebeck and Batavia, N. Y., Darlington, St. Charles, and Lykesland, S. C., Marshall and Waco, Tex., Walthill, Nebr., Charleston and St. Charles, Mo., and Morrell and Armorel, Ark.

Date begun.—1900.

Results.—It has been demonstrated that certain methods of corn breeding are practicable commercially and that variation of methods with different environments is necessary. Several strains of corn of unusual productivity have been

Production of Improved Strains of Corn for the Different Geographical Sections of the United States—Continued.

originated or improved and introduced. During the past fiscal year information was furnished to 25,000 correspondents, and 150 bushels of seed of new and improved varieties of corn were sent to 500 farmers in 47 States for testing in comparison with their best local varieties.

Assignment.—C. P. Hartley, E. B. Brown, C. H. Kyle, J. G. Willier, F. D. Richey, G. J. Burt, H. S. Garrison, H. M. Steece, C. D. Bennett, H. H. Biggar, A. A. Bryan, W. A. Reeves.

Proposed expenditures, 1916-17.—\$11,000.

Corn Improvement with Reference to Corn Products:

Object.—To develop types better suited to specific purposes in the manufacture of corn products; to determine methods of breeding, curing, and storage that will improve the popping qualities and wholesomeness of popcorn.

Procedure.—Comparative tests of the desired qualities are made, and isolated breeding plats planted from seed having these qualities most fully developed are maintained.

Cooperation.—Individual farmers, domestic-science schools, millers, and manufacturers.

Location.—Washington, D. C., Oconomowoc, Wis., Piketon, Ohio, and Edwardsburg and Vicksburg, Mich.

Date begun.—1910.

Results.—Information is being accumulated upon the culinary properties and palatability of meal made from different types of corn and from the same type by different processes; data upon popcorn published in Farmers' Bulletins 553 and 554.

Assignment.—C. P. Hartley, J. G. Willier.

Proposed expenditures, 1916-17.—\$2,000.

Study of Heredity and Environmental Effects:

Object.—To investigate the effects of inheritance and environment upon the plant and to determine general laws governing them; to develop and improve methods of corn breeding based upon the results of these studies.

Procedure.—The same variety or strain is tested under different environments, and different varieties and strains are tested under same environments.

Cooperation.—Individual farmers.

Location.—Observations throughout the United States; experimental plats located in New York, Virginia, South Carolina, North Carolina, Georgia, Florida, Mississippi, Louisiana, Texas, Oklahoma, Arizona, Missouri, Michigan, Ohio, Arkansas, Wisconsin, North Dakota, South Dakota, Nebraska, Colorado, Montana, and Nevada.

Date begun.—1901.

Results.—Data secured upon the degree and extent of inheritance of certain characters, and upon the effects of self-fertilization, close breeding, broad breeding, and crossbreeding; results published in Bureau of Plant Industry Bulletin 218. The possibility of developing frost-resistant strains adapted to earlier planting and capable of better yields at lower temperatures than existing varieties has been established.

Assignment.—C. P. Hartley, E. B. Brown, C. H. Kyle, J. G. Willier, F. D. Richey, G. J. Burt, H. S. Garrison, H. M. Steece, C. D. Bennett, H. H. Biggar, A. A. Bryan, W. A. Reeves.

Proposed expenditures, 1916-17.—\$10,000.

Seed-Corn Selection, Fumigation, Drying, and Preservation:

Object.—To develop and improve methods of seed-corn selection, fumigation, drying, and preservation.

Procedure.—Different methods of selection, fumigation, drying, and preservation are tested in different environments.

Cooperation.—Individual farmers.

Location.—Arlington Farm, Occoquan, and Round Hill, Va., Oconomowoc, Wis., Piketon and Sunbury, Ohio, Rhinebeck and Batavia, N. Y., Darlington, St. Charles, and Lykesland, S. C., Clarksdale, Miss., Marshall and Waco, Tex., Walthill, Nebr., Charleston and St. Charles, Mo., Morrell, Stuttgart, and Armorel, Ark., Edwardsburg, Vicksburg, and Ravenna, Mich., El Reno, Okla., and Terra Ceia, Fla.

Date begun.—1901.

Seed-Corn Selection, Fumigation, Drying, and Preservation—Continued.

Results.—Valuable methods have been developed and are now in practice in many corn-growing sections; methods must be modified to meet different environmental conditions.

Assignment.—C. P. Hartley, E. B. Brown, C. H. Kyle, J. G. Willier, F. D. Richey, G. J. Burt, H. S. Garrison, H. M. Steece, C. D. Bennett, H. H. Biggar, A. A. Bryan, W. A. Reeves.

Proposed expenditures, 1916-17.—\$9,000.

Methods of Corn Culture:

Object.—To improve and develop methods of corn culture; to determine fundamental principles that control stalk growth and grain production; to study the relation to stalk growth and grain production of the moisture content of the soil, the physical condition of the soil, methods of planting, cultivation, rotation, and fertilization.

Procedure.—Similar experimental tests are conducted in different environments.

Cooperation.—Individual farmers.

Location.—Observations throughout the United States; experimental plats located in New York, Virginia, South Carolina, Georgia, Mississippi, Louisiana, Texas, Arkansas, Missouri, Ohio, Michigan, Wisconsin, North Dakota, South Dakota, Nebraska, Colorado, Montana, and Nevada.

Date begun.—1901.

Results.—Data accumulated upon factors influencing stalk growth and grain production; methods of rotation, planting, cultivation, and fertilization developed for different environments.

Assignment.—C. P. Hartley, E. B. Brown, C. H. Kyle, J. G. Willier, F. D. Richey, G. J. Burt, H. S. Garrison, H. M. Steece, C. D. Bennett, H. H. Biggar, A. A. Bryan, W. A. Reeves.

Proposed expenditures, 1916-17.—\$3,000.

Total, Corn Investigations, \$42,380, including \$2,380 statutory.

[Research.]

TOBACCO INVESTIGATIONS.**Supervision:**

Object.—To provide for administrative and clerical routine, including correspondence, preparation of reports and manuscripts, and other general details connected with the field and laboratory investigations.

Location.—Washington, D. C.

Date begun.—1909.

Assignment.—W. W. Garner.

Proposed expenditures, 1916-17.—\$6,735.

New England Cigar-Wrapper Tobacco Investigations:

Object.—To develop principles and methods of breeding, growing, curing, and handling cigar-wrapper tobacco; to study the relation of environment to the development of the tobacco plant; to develop methods for controlling tobacco root-rot.

Procedure.—Native tobaccos are crossed with Cuban and Sumatra varieties and the character and behavior of the hybrids studied. The behavior of tobacco under different soil and climatic conditions and under different curing conditions is investigated. Experiments are made in curing tobacco in a centralized plant under controlled conditions. Field tests are carried out to determine the relations of methods of fertilizing and of parasites to the lack of productivity of tobacco soils.

Cooperation.—Connecticut Experiment Station and Harvard University.

Location.—Suffield and Tariffville, Conn.

Results.—The work of the past year indicates that selections from the Sumatra and Cuban crosses may yield valuable new types. Experiments with soil of unproductive spots in tobacco fields show that the trouble is due to tobacco root-rot.

In previous work an effective method of controlling diseases and weeds in tobacco seed beds by steam sterilization has been introduced. It has been demonstrated that the use of artificial heat eliminates losses from diseases in the curing barn. Methods of breeding applicable to the improvement of tobacco have been developed. Bureau of Plant Industry Bulletin 241 contains results of the work on curing.

New England Cigar-Wrapper Tobacco Investigations—Continued.*Date begun.*—1903.*Probable date of completion.*—1918.*Assignment.*—E. G. Beinhart, E. M. East.*Proposed expenditures, 1916-17.*—\$2,300.**Maryland Export Tobacco Investigations:***Object.*—To improve the crop by breeding and selection, determine the best use of fertilizers for tobacco, develop the best systems of rotation adapted to tobacco, and improve methods of growing, curing, and handling the crop.*Procedure.*—Pure strains of native tobacco varieties are developed by systematic selection, and new types are produced by crossing native and related foreign varieties, followed by careful selection. Plat tests are carried out to determine the proper kind and quantity of commercial fertilizers to obtain best results with tobacco. Field experiments are conducted with systems of crop rotation specially adapted to restoring the depleted humus supply of the tobacco soils.*Cooperation.*—Maryland Experiment Station.*Location.*—Upper Marlboro, Md.*Date begun.*—1905.*Results.*—The Maryland Mammoth type of tobacco has continued to give excellent results, and sufficient seed has been obtained for a considerable acreage to be grown in 1916 by farmers. A bulletin describing this and other new types has been issued by the Maryland Experiment Station. The past year was unfavorable for obtaining decisive results with fertilizers.

It has been shown that the growing of soil-improving crops greatly improves the yield and quality of the tobacco. No decided benefits have been obtained from the use of potash, but both nitrogen and phosphorus have given profitable returns. Important data on crop rotations for tobacco have been obtained.

Assignment.—D. E. Brown.*Proposed expenditures, 1916-17.*—\$1,500.**Burley Tobacco Investigations:***Object.*—To develop and test pure strains of standard Burley varieties, to determine fertilizer requirements and best systems of crop rotation for Burley tobacco, and to develop better cultural and curing methods.*Procedure.*—The more important varieties of Burley tobacco are subjected to comparative tests as to yield and quality, and pure strains of the better varieties are developed by seed selection. Tests with fertilizers and systems of crop rotation for Burley tobacco are carried out on sets of field plats. In the curing work, experimental curings are made in a specially constructed barn fitted with facilities for applying artificial heat. More attention will be given to fertilizer and rotation tests and curing problems.*Cooperation.*—Kentucky and West Virginia experiment stations.*Location.*—Milton, W. Va., and Lexington, Ky.*Date begun.*—Kentucky, 1906; West Virginia, 1913.*Results.*—A preliminary survey during the past year indicates that failure of the Burley crop, except where certain rotations are followed, is due to the tobacco root-rot disease, the aggregate damage from which is very large.

Pure lines of the standard varieties of Burley have been developed and seed distributed to farmers. In the Burley section of West Virginia there is need for better methods of growing and handling the crop.

Probable date of completion.—1919.*Assignment.*—C. H. Scherffius.*Proposed expenditures, 1916-17.*—\$1,000.**Western Fire-Cured Tobacco Investigations:***Object.*—To determine the fertilizer requirements and best systems of crop rotation for this type of tobacco; to develop better cultural methods for producing fire-cured tobacco.*Procedure.*—In order to develop methods for increasing the yield and maintaining good quality for the dark fire-cured tobacco, field test plats are arranged to bring out the most profitable use of fertilizers when combined with closer planting of the tobacco. A number of different systems of crop rotation are being tried out, all of which include tobacco as the leading money crop and one or more soil-improving crops.*Cooperation.*—Kentucky and Tennessee experiment stations.*Location.*—Clarksville, Tenn., and Hopkinsville, Ky.*Date begun.*—Kentucky, 1906; Tennessee, 1912.

Western Fire-Cured Tobacco Investigations—Continued.

Results.—During the past year moderate applications of phosphorus and nitrogen more than doubled the yield of tobacco. Additional data were obtained as to the relative values of different forms of nitrogen and phosphoric acid for tobacco.

More intensive methods and a restricted acreage for tobacco and further diversification of crops are required in these districts.

Probable date of completion.—1919.

Assignment.—R. H. Milton.

Proposed expenditures, 1916-17.—\$1,300.

New York Binder and Filler Tobacco Investigations:

Object.—To develop improved types of tobacco by seed selection, determine the most profitable use of fertilizers for the tobacco crop, and introduce systems of crop rotation adapted to the culture of binder and filler leaf.

Procedure.—Fertilizer tests with tobacco are conducted on a series of field plats. In the crop-rotation experiments the comparative merits of several different systems of rotation for tobacco culture are being tried out. Seed selection with the standard native varieties of tobacco is practiced with a view to obtain improved strains. Special attention will be given to the fertilizer and crop-rotation tests.

Cooperation.—New York (Geneva) Experiment Station.

Location.—Baldwinsville and Big Flats, N. Y.

Date begun.—1907.

Results.—During the past year the yields of tobacco from the different fertilizer plats varied from 1,520 to 2,150 pounds per acre. These tests with various kinds and quantities of nitrogenous, phosphatic, and potash fertilizers for filler tobacco, which have been in progress for several years, are becoming more and more valuable as time goes on. Several years will be required to obtain decisive results in the rotation tests designed to restore the productivity of run-down tobacco soils through the use of alfalfa and other soil-improving crops.

Probable date of completion.—1920.

Assignment.—G. W. Harris.

Proposed expenditures, 1916-17.—\$1,750.

Sun-Cured, Fire-Cured, and Flue-Cured Tobacco Investigations:**(a) SUN-CURED, FIRE-CURED, AND FLUE-CURED TOBACCO INVESTIGATIONS IN VIRGINIA—**

Object.—To determine more profitable methods of fertilizing the tobacco crop, develop systems of rotation adapted to tobacco culture, and improve present cultural methods.

Procedure.—Local stations are maintained in the three principal tobacco districts for carrying out experiments with fertilizers and in cultural methods.

Cooperation.—Virginia Experiment Station.

Location.—Appomattox, Chatham, and Bowling Green, Va.

Date begun.—1907.

Results.—During the past year additional data were obtained regarding the fertilizer requirements of the tobacco crop for the three principal types of leaf produced in Virginia.

In the work of the past several years it has been found that under proper conditions liberal fertilizing of the tobacco crop gives profitable returns, particularly when suitable systems of crop rotation are followed. Liberal applications of easily available phosphates properly balanced with nitrogen and potash have given best results. Several bulletins giving details of the experiments have been issued by the Virginia Experiment Station. Crimson clover has greatly increased the yield of tobacco in the sun-cured district.

Probable date of completion.—1917.

Assignment.—E. H. Mathewson.

Proposed expenditures, 1916-17.—\$1,325.

(b) FLUE-CURED TOBACCO INVESTIGATIONS IN NORTH CAROLINA—

Object.—To develop better tobacco varieties for flue curing; to improve fertilizer, rotation, cultural, and curing methods; to devise methods for the control of the Granville wilt.

Procedure.—Field experiments are conducted on leased lands at Reidsville and Creedmoor, N. C., and long-term experiments on a permanent location owned by the State at Oxford. In work on rotation special attention is given to the

Sun-Cured, Fire-Cured, and Flue-Cured Tobacco Investigations—Continued.
 use of soil-improving crops not injurious to the quality of tobacco. Special barns are used in the curing work. The control of the Granville wilt, based on the breeding of resistant varieties and the use of immune crops in systems of rotation, is undertaken.

Cooperation.—North Carolina Experiment Station.

Location.—Creedmoor, Oxford, and Reidsville, N. C.

Date begun.—1909.

Results.—The experiments of the past season have emphasized the importance of potash for the tobacco crop on the light soils of the State. The tests with the Granville wilt have demonstrated that the disease can be controlled through crop rotation, but a proper choice of crops is essential.

In the "Old-Belt" section three years' tests have shown large increases in the value of the crop through harvesting by the method of picking the leaves, instead of cutting the stalk, as has been done by growers. It has been shown that the leaf-spot disease can be largely controlled through the use of potash as a fertilizer. A bulletin is in course of preparation dealing with the improvements in curing methods which have been developed, whereby 50 per cent of the fuel required is saved.

Assignment.—E. H. Mathewson, E. G. Moss.

Proposed expenditures, 1916-17.—\$4,190.

(c) **FLUE-CURED TOBACCO INVESTIGATIONS IN SOUTH CAROLINA—**

Object.—To test and improve by selection standard varieties of tobacco, and to determine the best methods of fertilizing and culture.

Procedure.—Plat experiments with fertilizers, systems of rotation adapted to tobacco, and improved cultural methods are carried out on leased land for a series of years.

Cooperation.—Local boards of trade and farmers.

Location.—Timmons ville and Manning, S. C.

Date begun.—1910.

Results.—In the tests of the past year it was found that injury to the tobacco crop from nematodes, which are a serious pest on much of the tobacco land, can be largely controlled through the growing of crops in rotation which are more or less immune to attack.

Considerable data have been obtained on the fertilizer requirements of the tobacco crop when grown in rotation with other crops adapted to the maintenance of the humus supply in the soil without injuring the quality of the tobacco.

Probable date of completion.—1919.

Assignment.—E. H. Mathewson, J. P. Young.

Proposed expenditures, 1916-17.—\$3,100.

Pennsylvania Cigar-Filler Tobacco Investigations:

Object.—To improve the yield and quality of cigar filler and binder leaf by breeding and selection, and to develop better methods of growing, curing, and handling.

Procedure.—Selected strains of standard filler and binder varieties are tested as to yield and quality, fertilizer plat tests for improving the burning qualities and the yield of tobacco are carried out, and new cultural and curing methods are investigated. The seed-selection and fertilizer tests will be continued and more attention will be given to curing methods.

Cooperation.—Pennsylvania Experiment Station.

Location.—Landisville and Lock Haven, Pa.

Date begun.—1910.

Results.—The Slaughter strain of Pennsylvania Broadleaf, developed in the breeding work, has given such satisfactory results that several thousand acres of this type have been planted for the 1916 crop. In cooperative tests with farmers during the past year decided increases in yield were obtained by the use of phosphates as a supplement to barnyard manure.

Improvements in methods of handling seed beds, particularly steam sterilizing for the control of diseases and weeds, have been introduced, and a bulletin from the Pennsylvania Experiment Station giving details of the methods has been issued. It has been found that the use of improper fertilizers has been largely responsible for poor burning qualities.

Probable date of completion.—1919.

Assignment.—Otto Olson.

Proposed expenditures, 1916-17.—\$2,600.

Wisconsin Cigar-Binder Tobacco Investigations:

Object.—To improve the yield and quality of the tobacco crop, and to study and develop methods for the control of tobacco root-rot, black-rot, and other diseases attacking the tobacco in the field and after the crop has been harvested.

Procedure.—Field investigations will be undertaken to develop through breeding and selection improved types of binder leaf and to ascertain the fertilizer and other requirements of the Wisconsin tobacco crop. Field and laboratory investigations of tobacco diseases will also be conducted.

Cooperation.—College of Agriculture, University of Wisconsin.

Location.—Madison, Wis.

Date begun.—July 1, 1916.

Assignment.—James Johnson.

Proposed expenditures, 1916-17.—\$2,500.

Miscellaneous Tobacco Investigations:

Object.—To study the physiology, pathology, and chemistry of the tobacco plant in their relation to improved methods of growing, curing, fermenting, and handling the crop. This work supplies the fundamentals for the practical work in improving methods of tobacco production.

Procedure.—Work is carried on in laboratory, greenhouse, and field. The nature of the ripening, curing, and fermentation processes, the optimum conditions required, and the diseases met with are investigated. Causes of poor burning qualities and other properties are studied through chemical analyses and histological examination. Mosaic and other important diseases are studied by laboratory and greenhouse methods. The ripening and fermentation processes will receive special attention during the coming year.

Location.—Arlington Farm, Va., and Washington, D. C.

Date begun.—1906.

Results.—The nature of the "grain" of leaf tobacco and the relation of the grain development to burning qualities have been discovered, and the work is being prepared for publication. A bulletin giving the results of study of changes in composition taking place in tobacco fermentation also is being prepared. Important results have been obtained in a further study of the mosaic disease, and these have been published in the Journal of Agricultural Research, vol. 3, No. 4, and vol. 5, No. 6, and in outside scientific journals.

Important improvements in curing methods have been developed and the nature of the curing process thoroughly studied. Several papers relating to curing have been published. Information has been obtained on the factors governing the formation of nicotine in the tobacco plant and on the effects of soil and climate on the development of the plant. The causes of poor burning qualities have been investigated and the results published in bulletin form.

Assignment.—W. W. Garner, C. S. Ridgway.

Proposed expenditures, 1916-17.—\$3,100.

Total, Tobacco Investigations, \$31,400, including \$3,900 statutory.

[Research.]

PAPER-PLANT INVESTIGATIONS.**Paper-Plant Investigations:**

Object.—To investigate the value and suitability for paper-making purposes of various wild and cultivated plants and crop wastes, relevant paper-making processes and their application to such materials, the availability of these materials, and the conditions under which they are produced and assembled for market; and to breed such plants as may have a paper-making value.

Procedure.—Chemical and physical experiments are conducted in the investigation of plants to ascertain the best method of treatment. Laboratory work in the manufacture of sample sheets of paper is done to demonstrate the value of process and product. Paper-making tests on a large scale are conducted, in cooperation with manufacturers, to demonstrate the value of materials under commercial conditions of manufacture. Field investigations are made regarding the availability of materials and agricultural and assembling conditions.

Cooperation.—North Dakota Agricultural College and Bureau of Chemistry; cooperative mill tests with commercial companies at Cumberland Mills and Bar Mills, Me., Bridgeport, Pa., St. Paul, Minn., and Lawrence, Kans.

Location.—Washington, D. C.; mill tests as shown under "Cooperation."

Date begun.—1907.

Paper-Plant Investigations—Continued.

Results.—(1) During 1916: The principal work during the fiscal year 1916 was connected with hemp hurds and flax straw. It was found that hemp hurds can be utilized in the manufacture of high-grade printing and book papers, but since it does not appear that this material can as yet be produced in commercial quantities these investigations have been discontinued. Cooperative mill tests on flax straw have shown that it may be utilized in the production of trunk and fiber boards, and the product resulting from the tests was sold in the open market at the price regularly received for similar articles. Flax straw has been demonstrated to be suitable for employment in the manufacture of tough wrapping, cement-sack, and flour-sack papers. Cooperative mill tests concerning the possibilities of utilizing flax straw commercially are being conducted at present on an extensive scale. Publications: Department Bulletins 309, "Zacaton as a Paper Making Material," and 322, "Utilization of American Flax Straw in the Paper and Fiber Board Industry."

(2) Prior to 1916: Cooperative mill tests were conducted which demonstrated the possibility of making satisfactory and merchantable paper from cornstalks, broom corn, hemp stalks, hemp flyings, zacaton (*Epicampes macroura*), and *Yucca treculeana*; also the possibilities of utilizing flax tow in the manufacture of counterboards. A modified process of treating flax straw was devised, for which patent was requested April 7, 1916. Publications: Yearbook Separate 541 and B. P. I. Circular 82.

Assignment.—Charles J. Brand, Jason L. Merrill.

Proposed expenditures, 1916-17.—\$13,960, including \$3,120 statutory.

[Research.]

ALKALI AND DROUGHT RESISTANT PLANT INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To execute administrative affairs and conduct correspondence and laboratory work in connection with investigational projects.

Location.—Washington, D. C.

Date begun.—1907.

Assignment.—T. H. Kearney.

Proposed expenditures, 1916-17.—\$4,550, including \$2,300 statutory.

BREEDING AND PHYSIOLOGY OF ALKALI AND DROUGHT RESISTANT PLANTS.**Investigating the Alkali Resistance of Crop Plants:**

Object.—To ascertain by laboratory investigations and by field observations the relative adaptability of crop plants to alkali soils, and to study the physiological effects of alkali as a basis for the more scientific handling of crops grown on such soils.

Procedure.—Observations are made in the field upon different crop plants growing in alkali soils, in order to ascertain how the alkali affects them and to determine what species and varieties are most resistant. Determinations of the kind and quantity of salts present are made in this connection. Such observations form the basis for recommendations of crop plants adapted to growing on alkali soils. These observations are supplemented by experiments in the greenhouse upon plants grown in the presence of the different salts which occur in natural alkali soils, and the effect of these salts upon the structure and physiological functions of the plants are thus determined under carefully controlled conditions.

Investigations of the relations between the alkali content of the soil and the water requirement and other physiological processes of crop plants will be continued. Information concerning the behavior of different crop plants in different types of alkali soil will be collected as a basis for recommendations to farmers concerning what crops to grow on alkali land.

Location.—Laboratory work at Washington, D. C.; field work at various points in the States of Arizona, California, Nevada, Utah, Colorado, and other Western States where irrigation is extensively practiced.

Date begun.—1907.

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Investigating the Alkali Resistance of Crop Plants—Continued.

Results.—During the year 1915 experiments with wheat and alfalfa in soils of graduated alkali content have shown that the water requirement increases markedly when the quantity of alkali present is sufficient to impair the growth of the plants. The ash content of wheat was found to increase rapidly with the increasing alkali content of the soil, while in the case of alfalfa the increase was less marked.

The comparative alkali resistance of the crops commonly grown under irrigation in the United States was determined by several years' experimentation in the field, and the results were published in Farmers' Bulletin 446. Special studies of the alkali resistance of the pomegranate and of Egyptian cotton (B. P. I. Circular 112) have been made in connection with other projects of the office.

The relation of alkali to orchard malnutrition troubles in western Colorado and southern California has been investigated in cooperation with the Office of Biophysical Investigations. Studies have been made of the alkali resistance of the date palm in northern Africa (B. P. I. Bulletins 80 and 92) and of the use of crops in reclaiming alkali land in Egypt (Department Yearbook for 1902). The relative harmfulness and specific effects upon plant growth of the different alkali salts have been the subject of laboratory experiments. Data published in Department Report 71, B. P. I. Bulletins 79, 113, and 134, and B. P. I. Circular 109.

Assignment.—T. H. Kearney.

Proposed expenditures, 1916-17.—\$1,000.

Investigating the Physiology of Drought Resistance:

Object.—To determine the causes of drought resistance by investigating the function and structure of crop plants, and to furnish a physiological basis for plant breeding, variety testing, and investigations of cultural methods in connection with dry-land agriculture.

Procedure.—Field observations are made upon the structure and functions of crop plants when the water supply is deficient. Measurements are made of the quantity of water used by the different species and varieties in producing a given weight of dry matter, in order to determine their relative efficiency in the use of water. The results of these observations and experiments make it possible to determine the comparative drought resistance and the adaptability to dry-land agriculture of the different crop plants.

Location.—Laboratory work at Washington, D. C.; field work at bureau experiment farms at Akron, Colo., Moro, Oreg., Newell, S. Dak., Amarillo, Tex., and Arlington Farm, Va.

Results.—(1) During 1916: The investigations of the past year dealt largely with the effect of climatic conditions on the loss of water by crops. During mid-day water is lost at a rapid rate, the loss in a single hour amounting to about one-tenth of the total loss for the 24 hours. On a clear day a 20-acre field of alfalfa which will produce a ton of dry matter at a cutting will lose a ton of water each minute during the midday hours. A field of wheat which will produce 30 bushels per acre may lose as much as an inch of water a day during a period of hot wind. Determinations of the rate at which water is consumed by crops at different periods of the year indicate that about one-fourth of the total water required for the season is lost during a 10-day period succeeding heading. Studies made on clear days indicate that sunlight, temperature, and dryness of the air are about equally important in determining the loss of water from crop plants. Similar results are obtained from a consideration of the daily measurement throughout the season. The loss of water by transpiration from the plants on different days was most nearly proportional to the loss from a free-water surface by evaporation and to the dryness of the air as measured by a wet-bulb thermometer. Publication: "Hourly Transpiration Rate on Clear Days as Determined by Cyclic Environmental Factors," Journal of Agricultural Research, vol. 5, No. 14.

(2) Prior to 1916: Under this project the two chief lines of investigation followed have been to determine (a) the relative ability of different plants to reduce the percentage of moisture in a soil and (b) the amount of moisture required by different plants to produce a pound of dry matter. The point to which different plants reduce the soil moisture was found to be practically the same and to bear a relatively constant relation to the purely physical measurements of the moisture-holding capacity of the soil. At Akron, Colo., the amount of water required to produce a ton of dry crop is 2.6 acre-inches for millet, from 2.4 to 2.9 acre-inches for sorghum, from 2.7 to 3.5 for corn, from

Investigating the Physiology of Drought Resistance—Continued.

4 to 4.7 for wheat, from 4.3 to 4.9 for barley, from 4.7 to 5.3 for oats, 3.4 for sugar beet, 4.7 for Irish cobbler potato, 6.7 for clover, and 7.2 for Grimm alfalfa. Of the native plants, pigweed and tumbleweed require about 2.5 acre-inches, while sunflower requires about 7 acre-inches of water to produce a ton of dry matter. In a cool climate alfalfa may require only 4.4 acre-inches to produce a ton of dry crop, while in a hot, dry climate more than 8.5 acre-inches are required. Publications: "The Wilting Coefficient of Different Plants and Its Indirect Determination," B. P. I. Bulletin 220; "Water Economy of Dry-Land Crops," Department Yearbook for 1911; "The Water Requirement of Plants," B. P. I. Bulletins 284 and 285; "Relative Water Requirement of Plants," Journal of Agricultural Research, vol. 3, No. 1; "Effect of Frequent Cutting on the Water Requirement of Alfalfa and Its Bearing on Pastures," Department Bulletin 228; "Influence of Hybridization and Cross-Pollination on the Water Requirement of Plants," Journal of Agricultural Research, vol. 5, No. 3.

Assignment.—H. L. Shantz.

Proposed expenditures, 1916-17.—\$7,055.

Indicator Value of Native Vegetation in Arid Regions:

Object.—To work out methods for utilizing native vegetation in classifying new land as to its agricultural value by establishing correlations between different types of natural growth and the soil moisture and alkali conditions of the corresponding types of land.

Procedure.—In a given area the different types of native vegetation are classified and the character of the land upon which each type occurs is determined, special attention being given to the moisture relations and salt content of the soil. If crops are being grown, the yield and behavior of the cultivated plants are studied in order to correlate the crop-producing capabilities of the land with the kind of native growth which it originally produced. When these correlations have been worked out in detail in a limited area it becomes possible to classify land with respect to its agricultural capabilities throughout the region where these particular types of vegetation occur.

Location.—Arid and semiarid portions of United States—Great Plains and Great Basin regions.

Date begun.—1910.

Results.—(1) During 1916: Further studies of the correlations between the types of native vegetation and the soil-moisture conditions and alkali content of the corresponding types of soil have been carried on in Utah, southeastern California, and southern Arizona. In all of these regions it has been found that new land can be successfully classified as to its agricultural capabilities on the basis of the natural growth. In southeastern California and southern Arizona the two best types of agricultural land have been found to be characterized, respectively, by a growth of creosote bush and of a species of salt bush.

(2) Prior to 1916: The first investigations under this project were made in eastern Colorado and the results published in B. P. I. Bulletin 201, "Natural Vegetation as an Indicator of the Capabilities of Land for Crop Production in the Great Plains Area." Three important types of vegetation—short grass, wire grass, and bunch grass—were distinguished, and marked differences were detected in the moisture relations of the soils occupied by each of these types. The bunch-grass land, into which water penetrates most readily and to the greatest depth, was found to be the safest for dry-land crop production in very dry years, while the characteristics of short-grass land are such that it will yield heavy crops in exceptionally favorable seasons but at other times is very likely to suffer from drought. Wire-grass land was found to offer a safe intermediate condition. In the Great Basin or intermountain region this problem has been studied in the States of Wyoming, Utah, Nevada, and Oregon, the most detailed investigations having been made in a representative region in central Utah; paper entitled "Indicator Significance of Vegetation in Tooele Valley, Utah," published in Journal of Agricultural Research, vol. 1, No. 5. Throughout this region land which in the natural condition is covered with a heavy growth of sagebrush is found to be best adapted to dry farming and to require no reclamation when irrigated. A vegetation of shadscale, which also covers vast areas in the Great Basin, indicates less favorable conditions for moisture penetration and often the presence of alkali at a relatively slight depth in the soil. The presence of greasewood indicates a high water table and usually an excessive quantity of alkali salts, but when drained and under irrigation this type of land can often be made very productive.

Assignment.—T. H. Kearney, H. L. Shantz.

Proposed expenditures, 1916-17.—\$2,650.

Breeding Drought-Resistant Field Crops:

Object.—To work out methods for breeding more drought-resistant strains of field crops adapted to dry-land agriculture, and to devise improved methods of testing comparative drought resistance.

Procedure.—Individual plants are selected which give indications in their structure and behavior of superior drought resistance, and their progenies are grown in parallel rows and compared with respect to drought resistance, water requirement, productiveness, and general desirability. Those strains which prove to be best adapted to conditions of drought without impairment of other valuable qualities are chosen for distribution to farmers through the Office of Seed Distribution.

Location.—Newell and Ardmore, S. Dak., Akron, Colo., and Mandan, N. Dak.

Date begun.—1908.

Results.—Seed of the improved strains of sorgo and millet, which are described in Department Bulletin 291, "Breeding Millet and Sorgo for Drought Adaptation," is being increased for distribution to dry-land farmers in the northern Great Plains through the Office of Seed Distribution. The choice among the improved strains of alfalfa developed for use in dry-land agriculture in the Great Plains has been narrowed to three or four, which are being tested comparatively in order to make a final choice for increase and distribution. All of these strains give indication of better adaptation to the climatic conditions and of greater productivity than the commercial varieties commonly grown in this region. Final tests are also being made of two or three improved selections of smooth brome grass which give indications of superior adaptability and productiveness. The water requirement of the new strains of each of these crops is being tested in comparison with standard commercial varieties, as this is the most reliable method for the rapid determination of comparative drought resistance which has thus far been devised.

Assignment.—T. H. Kearney, A. C. Dillman.

Proposed expenditures, 1916-17.—\$3,135.

Breeding and Culture of Pomegranates:

Object.—To obtain by introduction and breeding drought-resistant and alkali-resistant varieties of pomegranates.

Procedure.—Through the Office of Foreign Seed and Plant Introduction promising varieties of pomegranates have been introduced from various foreign countries and are being tested side by side at a number of stations in the southwestern United States. The different varieties are compared with respect to their adaptability to the local climatic and soil conditions, their yield, and the size and quality of their fruit. Those which give the best results are propagated for distribution to growers in the region to which they have proven adapted.

Location.—Washington, D. C., Sacaton, Ariz., Bard and Indio, Cal., and San Antonio, Tex.

Date begun.—1907.

Results.—Selection has been made of a number of the most promising varieties in the experimental gardens at Chico, Cal., and Sacaton, Ariz., and these are being propagated for distribution to growers of the fruit in the Southwestern States. In cooperation with the Office of Indian Affairs, rooted plants of one of the best sweet-fruited varieties in the collection at Sacaton have been distributed to Indians on the Pima Reservation.

Assignment.—T. H. Kearney.

Proposed expenditures, 1916-17.—\$140.

Total, Breeding and Physiology of Alkali and Drought Resistant Plants,
\$13,980.

EGYPTIAN COTTON BREEDING.**Egyptian Cotton Breeding and Alkali-Resistance Investigations in the Arid Southwest:**

Object.—To secure varieties of Egyptian cotton yielding fiber of superior quality and thoroughly adapted to growing under irrigation in the southwestern United States.

Procedure.—Ordinary methods of plant breeding are followed. The most promising strains are tested on a field basis, and seed of the one which yields best and of which the fiber gives the best results in spinning tests is distributed to farmers. Studies are made of the behavior of the plants on soils having different salt content and different moisture conditions, in order to ascertain what soils are best adapted to this crop.

Egyptian Cotton Breeding and Alkali-Resistance Investigations in the Arid Southwest—Continued.

Cooperation.—Cooperative cotton-growers' organizations.

Location.—Sacaton, Ariz., and the Salt River Valley.

Date begun.—1907.

Results.—(1) During 1916: The status of Egyptian cotton as a commercial industry in Arizona up to and including the year 1914 is described in Department Bulletin 332, "Community Production of Egyptian Cotton in the United States." In 1915 only about 1,000 bales of this cotton were produced in Arizona, but the prices obtained by the growers were satisfactory, ranging from 21 to 23 cents per pound. A preliminary estimate of the acreage planted in 1916 is 10,000 acres. In cooperation with the Salt River Valley Egyptian Cotton Growers' Association, 100 acres of the Yuma variety were rogued by agents of the department in 1915 in order to obtain pure seed for commercial planting. The results indicated that the work in pure seed maintenance is proving successful and that the uniformity of the variety is being maintained by this method. Breeding work is being continued with a new variety, which has somewhat longer staple than the one now commercially grown and which also possesses certain cultural advantages. Very satisfactory reports have been received from manufacturers who have tested this cotton, the consensus of opinion being that it can be satisfactorily substituted for the best Sakellarides cotton, of which an unprecedented quantity has been imported from Egypt during the past year, chiefly for manufacturing automobile-tire fabrics. The eight bales of this new cotton produced at Sacaton in 1915 have been sold by the Indian Office to three of the largest spinning firms in the world, in order that thorough tests of the spinning value of the fiber may be obtained. Two hundred and eighty acres in the Salt River Valley have been planted to this variety in 1916 in order to test thoroughly its agricultural and commercial possibilities and to furnish seed for increase in case the tests result favorably.

(2) Prior to 1916: The earlier stages in the introduction of Egyptian cotton into the southwestern United States, including descriptions of the plant-breeding methods employed and of the new varieties developed, were treated in the following publications: B. P. I. Bulletins 128 and 200, B. P. I. Circulars 29, 110, and 112, Journal of Agricultural Research, vol. 2, No. 4, and Department Bulletin 38.

Assignment.—T. H. Kearney, W. G. Wells.

Proposed expenditures, 1916-17.—\$5,550.

ECOLOGY OF CROP PLANTS.

Ecology of Crop Plants:

Object.—To apply physiological and ecological methods to the problem of plant production, and, by comparative study of the physiological processes and the individual response of plants to a wide range of climatic conditions, to determine the individual peculiarities of plants as a means of explaining their success or failure under cultivation in any particular environment.

Procedure.—A comparative study of the structure, functions, and growth of crop plants will be made under a wide range of field conditions, with the view of determining what peculiarities of structure and function are of importance in adapting these plants to any particular environment; these studies to be carried out for the purpose of determining the adaptability of the different crops to withstand different conditions of light, heat, humidity, and moisture supply.

Location.—Laboratory work at Washington, D. C.; field work at the experiment farm of the bureau at Akron, Colo., and at such other locations as are suitable for cooperative work.

Date begun.—July, 1916.

Results.—Some work has already been done along this line by the Office of Alkali and Drought Resistant Plant Investigations in connection with the adaptability of crops to alkali and drought resistance. Cooperative experiments have been under way for some years with the Office of Biophysical Investigations and are now being carried out informally with the Offices of Cotton and Truck Disease and of Cereal Investigations.

Assignment.—H. L. Shantz.

Proposed expenditures, 1916-17.—\$500.

Total, Alkali and Drought Resistant Plant Investigations, \$24,580, including \$2,300 statutory.

[Research.]

SUGAR-BEET INVESTIGATIONS.**Supervision:**

Object.—To administer the funds, handle correspondence, keep all records, and give general oversight to the field, laboratory, and office work.

Location.—Washington, D. C.

Date begun.—1914.

Assignment.—C. O. Townsend.

Proposed expenditures, 1916-17.—\$4,260.

Investigation of the Status of the Sugar-Beet Industry in the United States:

Object.—To determine the present status of the sugar-beet industry in each general locality where the industry now exists; to determine what the limiting factor or factors for sugar-beet production are in each sugar-beet center; to determine whether or not the limiting factor or factors, so far as sugar-beet growing is concerned, are surmountable or insurmountable from an economic standpoint.

Procedure.—An economic farm-to-farm and factory survey will be made of the sugar-beet centers, in which all the factors, both direct and indirect, that have any bearing upon sugar-beet growing, harvesting, and delivery will be considered and given their proper value, with due regard to the place and value of other crop and live-stock interests on the farm as a unit and the community as a whole.

Cooperation.—Office of Farm Management; Office of Extension Work in the North and West, States Relations Service; sugar companies, and individual farmers.

Location.—Arizona, California, Colorado, Idaho, Michigan, Nevada, Ohio, Utah, Wisconsin, Indiana, Illinois, Minnesota, Nebraska, Kansas, Montana, Wyoming, and other States possessing possible sugar-beet areas.

Date begun.—1914.

Results.—A general survey has been made of all existing sugar-beet areas, and some of the limiting factors, with methods of control, have been pointed out to those directly interested.

Assignment.—C. O. Townsend.

Proposed expenditures, 1916-17.—\$13,000.

Economic Practice in Crop Production in Sugar-Beet Areas:

Object.—To determine what relations, if any, exist between the sugar beet and the other farming and live-stock operations now existing in a given territory.

Procedure.—An economic farm-to-farm survey covered by the original survey plus the survey covering the production, buying, marketing, and other factors bearing directly or indirectly upon the possible new lines of agriculture will be made. Cooperation of the best farmers in each community will be secured in doing those things that will lead to the best system of crop rotation and live-stock production, with a view to establish an improved, permanent, and progressive agriculture. This work also includes a study of local cultural methods with a view to their improvement, the cause and control of beet diseases, local labor and marketing conditions, and all other factors that bear upon the production and handling of the sugar-beet crop, so that the grower will receive the largest possible returns for money and labor invested. In case of radical changes in local agricultural methods or crop production, specific demonstrations may be necessary to accomplish the desired result.

Cooperation.—Bureau of Chemistry, Bureau of Animal Industry, Office of Farm Management, States Relations Service, farmers' organizations, sugar companies, and individual farmers.

Location.—Chino, Huntington Beach, Santa Ana, and Betteravia, Cal., Lehi, Utah, Aberdeen and Idaho Falls, Idaho, Billings, Mont., Fort Collins, Fort Morgan, Greeley, and Rocky Ford, Colo., Blissfield, Mich., Toledo, Ohio, and other points in the States mentioned.

Date begun.—1914.

Results.—Approximately 2,000 individual farm records have been obtained. These data are being tabulated and the results taken back to the farmers in the form of illustrated lectures, multigraphed letters, printed matter, and field demonstrations and by means of personal interviews.

Probable date of completion.—The survey will be completed in from three to five years. The demonstration work is being carried along conjointly with the survey, but it will require somewhat longer time to make the necessary adjustments.

Assignment.—C. O. Townsend.

Proposed expenditures, 1916-17.—\$13,135.

Sugar-Beet Seed Production:

Object.—To determine the conditions under which an adequate supply of sugar-beet seed may be produced in this country in an emergency; to determine the conditions under which commercial beet-seed production may be made a permanent part of our agricultural operations, thereby insuring a stable agriculture for those sections in which sugar beets appear to be vital to the best interests of the farmer; to determine the correlation between the external character of the beet and the quality (sugar, purity, and yield) of the root, and to breed out a line of beets in which the quality (sugar, purity, and yield) of the roots will correspond to one or more well-defined external characters of leaf and root, with due regard to quality and yield of seed. Cooperation will be maintained with the Bureau of Chemistry and with other offices of the Bureau of Plant Industry, with State experiment stations, sugar companies, seedsmen, and farmers, in order to most quickly, economically, and effectively accomplish the desired results.

Procedure.—So far as practicable, the beet growers, sugar companies, and seedsmen will be advised and assisted in the various steps needed in commercial beet-seed production in the shortest possible time. This will involve all the steps from the selection and storing of the roots on a large scale to the harvesting and cleaning of the mature seed. The conditions under which a paying crop of satisfactory beet seed may be produced commercially each year will be studied and the relation of soil and climatic conditions, methods of handling the roots, and the influence of pests and other factors on the successful production of commercial sugar-beet seed determined. Present known types or strains of sugar beets will be selected from those individuals of distinctive type or character which show the best quality and yield of seed. Those individuals will be bred by the plant-to-row method until the desired type is fixed, that is, until a given type of leaf and root comes true and indicates quality and yield of seed and roots. As many types or strains of the wild beet as possible will be obtained for test along the lines indicated above, with the hope of finding a type that will give better results than any of the present domestic types. In case one type shows quality and another shows yield, they will be crossbred and a new strain originated combining quality and yield, and from this will be developed a pure strain having these combined characters. The strains must be widely separated during the season of seed production to keep them pure.

All the above work will be coordinated so that the production of commercial beet seed for emergency purposes and the determination of the adverse and favorable factors influencing the annual production of the crop will fit into the economic factors of the improvement of the beet root and the cost of seed production; that is, all this work is to be carried on simultaneously and under such conditions that there will be as little lost motion as possible.

Cooperation.—Bureau of Chemistry, State experiment stations, beet-sugar companies, and individual farmers.

Location.—Blissfield, Mich., Rocky Ford and Fort Collins, Colo., Lehi and Garland, Utah, Aberdeen, Idaho Falls, and Sugar City, Idaho.

Date begun.—1915.

Results.—There will be several thousand acres of beet seed produced in the United States this year, by far the largest area that this country has produced. A large number of selections of individual plants has been made. These plants have been carefully described, photographed, and the roots tested, thus laying the foundation for a highly developed strain of American-grown sugar-beet seed.

Probable date of completion.—In part, in two years; other phases of the work will require from 5 to 10 years.

Assignment.—C. O. Townsend, W. W. Tracy, jr.

Proposed expenditures, 1916-17.—\$12,000.

Total, Sugar-Beet Investigations, \$42,395, including \$900 statutory.

[Research.]

SUGAR-CANE SIRUP PRODUCTION.**Sugar-Cane Sirup Production:**

Object.—To conduct investigations in connection with the production of table sirup, including the breeding, culture, and diseases of cane, the methods of manufacture, standardization, and marketing of sirup, and the utilization of cane by-products, with special reference to the farm production of cane sirup.

Sugar-Cane Sirup Production—Continued.

Procedure.—All of the promising standard varieties of sugar cane now used in the sirup belt will be tested in field plots to determine which ones are best adapted to the production of a high quality of sirup. New and promising varieties of cane from Louisiana, Porto Rico, Cuba, and the West Indies, especially quick-maturing or good-yielding strains and varieties resistant to root diseases or red-rot and good in ratooning, will be introduced and tested in the sirup belt after they have been grown for a period of time at quarantine stations to prevent the introduction of serious diseases or insect pests. Experiments will be conducted with various methods of culture, types of soil, fertilizers, and crop rotations to determine which are the best and most economical for the production of sugar cane for sirup purposes. Diseases of sugar cane will be studied and methods for their control worked out. An effort will be made to improve sirup-making machinery and operations, with the aim of improving the quality and of securing greater uniformity in the product and of increasing the yield and cheapening the process, with special reference to farm outfits for sirup making; to produce sirup from the cane crops grown on the various experimental plats, making suitable tests of the quality of the juice and sirups resulting; and to conduct experiments in the utilization of sugar-cane by-products, such as tops, bagasse, and skimmings. Experiments on sugar-cane sirup production, involving the various methods of clarification and filtration of sirup, the prevention of crystallization through the use of invertase or other methods, the analysis of samples of cane sirup from various parts of the sugar-cane belt, and the manufacture of sirup on an experimental scale from the different varieties under various cultural conditions, etc., will also be conducted, this part of the work to be done by the Bureau of Chemistry.

Cooperation.—Bureau of Chemistry, Wight Realty Co., Cairo, Ga., George E. Dunan, Apalachicola, Fla., and individual farmers.

Location.—Cairo, Ga., Apalachicola, Fla., and other points in the cane-producing States.

Date begun.—1913.

Results.—Two years' data have been collected on spacing and rate of planting tests, on feeding of by-products, and on sirup-canning experiments, and one year's data on other field tests and on methods of storing seed cane. Twenty-seven varieties have been collected on the experiment field and are being propagated, of which 21 are new to this locality. A number of other varieties which have been collected are on hand in the greenhouse at the Rockville, Md., plant-introduction field station, to be transferred to Cairo, Ga., when released from quarantine. New sirup-making apparatus have been designed, including a steam-bottom evaporator, a density indicator, and an automatic inflow regulator, and the evaporator has been used through one season. Publications are in preparation on the present practices in sugar-cane production and in sirup making, on the farm economics of the sirup industry, and on cane diseases in the United States. Application has been filed for a patent in the name of the Department of Agriculture for the steam-bottom sirup evaporator.

Probable date of completion.—Three to six years.

Assignment.—C. O. Townsend, P. A. Yoder.

Proposed expenditures, 1916-17.—\$6,300, including \$300 statutory.

[Research.]

INVESTIGATIONS IN ECONOMIC AND SYSTEMATIC BOTANY.**SUPERVISION.****Supervision:**

Object.—This covers the supervisory and routine work of the office and laboratory, including the investigations carried on in the greenhouses.

Procedure.—It is part of the duty of the office to furnish the various branches of the department the correct names of plants the identity of which is a matter of importance in their work. For this purpose the office employs expert botanists and maintains a herbarium of cultivated plants (used to supplement the National Herbarium, which is under the Smithsonian Institution).

Cooperation.—National Herbarium.

Location.—Washington, D. C.

Date begun.—1868.

Assignment.—Frederick V. Coville.

Proposed expenditures, 1916-17.—\$5,674, including \$2,424 statutory.

BIBLIOGRAPHICAL WORK IN THE INTEREST OF BOTANICAL SCIENCE.

Bibliographical Work in the Interest of Botanical Science:

Object.—To improve bibliographical facilities for botanical workers in Washington.

Procedure.—A card catalogue, both subject and author, is maintained, which not only represents the resources of the Washington libraries in botany and horticulture, but also by the inclusion of entries for books that are needed, serves as a guide in the purchase of works on these subjects. Index entries for current scientific serials or society publications are included. A list of scientific serials or society publications containing botanical or horticultural material is also maintained. A bibliography of horticulture is in process of compilation. An index of botanical illustrations to supplement Pritzel's *Icones* was begun last year.

Cooperation.—Department library and Library of Congress.

Location.—Washington, D. C., and various large libraries of other cities.

Date begun.—1903.

Assignment.—Marjorie F. Warner, Alice C. Atwood.

Proposed expenditures, 1916-17.—\$2,800, including \$2,600 statutory.

RANGE INVESTIGATIONS.

Range Investigations:

Object.—To develop increased forage on the overgrazed range lands of the national forests and elsewhere.

Procedure.—Methods are devised for the improvement of wild grazing lands, in cooperation with the Forest Service. This office furnishes expert advice. Most of the details of the investigation are carried out by the Forest Service.

Cooperation.—Forest Service.

Location.—Washington, D. C., and Western States.

Date begun.—1907.

Results.—It has been demonstrated that overgrazed areas can be abundantly revegetated without the necessity of closing them to stock, by timing annual grazing to permit seed formation. Furthermore, grazing at proper seasons results not only in a greater yield for the year but in increased root vigor and the consequent ability of the plants to produce heavier yields in succeeding years. Sheep fenced in and not herded produce more wool and mutton on much less range than by the ordinary methods.

Assignment.—Frederick V. Coville.

Proposed expenditures, 1916-17.—\$2,383, including \$233 statutory.

ECONOMIC BOTANY OF NATIVE PLANTS.

Economic Botany of Mexico, with Special Reference to the Utilization of Valuable Species in the United States:

Object.—To make available for public use information on the useful native plants of Mexico.

Procedure.—This project involves a study of material in the department's economic collection and of all specimens of plants, roots, fruits, or vegetable products submitted for identification; the acquisition of supplementary material when necessary, and consultation with experts in the various offices of the Bureau of Plant Industry, Forest Service, Bureau of Chemistry, and the United States National Museum, in order to obtain reliable information; the correlation of all collectors' notes and statements of those submitting plant products for study with information already published as to the properties of the plants under study; the identification of important economic plants, drugs, dyestuffs, resins, balsams, spices, fruits, and other plant products described by early explorers and writers, with material in our collections; finally, the systematic grouping of these facts and the publication of descriptions of species which prove to be new to science.

Cooperation.—National Herbarium.

Location.—Washington, D. C.

Date begun.—1899.

Results.—(1) During 1916: Owing to the close relationship between the flora of Mexico and that of Central and South America, the scope of the work on the economic plants of Mexico has been broadened, and the following publications have been issued: "An Aztec Narcotic (*Lophophora Williamsii*)," *Journal of*

Economic Botany of Mexico, with Special Reference to the Utilization of Valuable Species in the United States—Continued.

Heredity, vol. 6, 291-311, 1915; "The Botanical Identity of Lignum Nephriticum," Science, new series, vol. 45, 432-433, 1916; "Eysenhardtia Polystachya, the Source of the True Lignum Nephriticum Mexicanum," Journal of the Washington Academy of Science, vol. 5, 503-517, 1915; "Rolliniopsis, a New Genus of Annonaceae from Brazil," Journal of the Washington Academy of Science, vol. 6, 197-204, 1916; "Desmopsis, a New Genus of Annonaceae," Bulletin Torrey Botanical Club.

(2) Prior to 1916: An enormous quantity of material collected by Dr. Edward Palmer and others in Mexico and adjoining countries has been studied. The results are embodied in a manuscript not yet in shape for publication, which is intended as the basis of a handbook of the useful plants of tropical and sub-tropical America. The need for such work is indicated by the frequent inquiries, to which answers are made for the most part by copying parts of the manuscript mentioned. These inquiries are wide in their scope, touching food and forage plants, drugs, tanning, and dye plants, narcotics, poison plants, copals, balsams, and gums. They come from the Department of Commerce, the National Museum, Bureau of Fisheries, the Forest Service, various offices of the Bureau of Plant Industry, and from the Bureaus of Animal Industry and Chemistry. They are also received from public economists, from commercial and manufacturing firms, applicants for patent medicines, and other private individuals.

Assignment.—W. E. Safford.

Proposed expenditures, 1916-17.—\$3,716.

Plants Used by the American Aborigines:

Object.—To record information possessed by the aborigines regarding the uses of plants.

Procedure.—All available literature on exploration, early travels, and settlement in this country, as well as publications of a later date, that may have a bearing on aboriginal matters are consulted in various libraries with reference to plant subjects. The information thus found is abstracted and filed under the botanical name of the plant referred to. An index of authors and works consulted is also made.

Cooperation.—National Herbarium.

Location.—Washington, D. C., and Western States.

Date begun.—1891.

Results.—A paper entitled "Grasses Used by the Indians" has been prepared.

An index, and abstracts leading to a series of manuscripts for publication, have been partially completed.

Probable date of completion.—1924.

Assignment.—Frederick V. Coville.

Proposed expenditures, 1916-17.—\$2,134.

Total, Economic Botany of Native Plants, \$5,850, including \$900 statutory.

BOTANY OF THE ECONOMIC GRASSES.

Manual of North American Grasses:

Object.—To produce a descriptive manual of the grasses of the United States.

Procedure.—Material is gathered from the region covered and arranged and studied.

All possible information from literature is collected. Individual groups of grasses which are finally to be published in monographic form are studied.

Cooperation.—National Herbarium.

Location.—Washington, D. C., and various parts of North America.

Date begun.—1905.

Results.—A paper entitled "Tropical American Species of Panicum" has been published in Contributions from the National Herbarium, vol. 17, part 6; a paper on the "Grasses of the West Indies" is in preparation; and papers on the "Genera of the Grasses of the United States" and on "A Revision of the Genus Paspalum in North America" are partially completed. A mass of information is being accumulated for use in the forthcoming manual.

Probable date of completion.—1924.

Assignment.—A. S. Hitchcock.

Proposed expenditures, 1916-17.—\$2,646.

Grass Introduction Index:

Object.—To maintain a card index, containing all references to the uses of grasses except the common agricultural uses, references to common names, extracts from notes of travelers, and other information, for the purpose of assisting the Office of Foreign Seed and Plant Introduction in securing valuable grasses for introduction into the United States.

Procedure.—The work on this project consists in looking over literature and extracting the information needed. Part of this is current literature obtained from periodicals and is placed in catalogue form. Besides this, books of the past are worked on as time permits.

Location.—Washington, D. C.

Date begun.—1910.

Results.—Index continued and many cards added.

Assignment.—A. S. Hitchcock.

Proposed expenditures, 1916-17.—\$621.

Economic Grass Collection:

Object.—To obtain a collection of native and cultivated grasses of the world as material for study under various grass projects; and to study the grasses and forage plants of the Hawaiian Islands, with special reference to their economic uses, report on the native grasses and the possibility of cultivating them for forage, aid the Hawaiian Experiment Station to prepare a herbarium of native and introduced grasses and to establish promising species in the grass garden of the station, and cooperate with the director of the Hawaiian Experiment Station in studying the question of a forage supply for the horses of the United States Army.

Procedure.—The grass herbarium is kept in order. The specimens have to be mounted and arranged so as to make the information available in classified form. A survey of the Hawaiian Islands will be made during the present summer for the purpose of securing whatever information may be had and arrangements made with the Hawaiian Experiment Station as outlined under "Object."

Cooperation.—National Herbarium and Hawaiian Experiment Station.

Location.—Washington, D. C., and points in Hawaiian Islands.

Date begun.—General collections, 1868; work in Hawaii will be undertaken during the season of 1916.

Results.—The herbarium specimens from the United States have been arranged geographically so that those from a given State may be readily consulted. The grass collection has more than doubled in the last 10 years and is now the largest in the world, containing about 120,000 sheets. Keys to the species have been prepared for all the genera in the United States, and the specimens have been arranged so as to be readily accessible and easily consulted. The material now at hand is nearly sufficient for the preparation of the remaining monographs of large genera and for the final incorporation of all the results in the Manual of North American Grasses. The work in Hawaii is just starting.

Assignment.—A. S. Hitchcock, Agnes Chase.

Proposed expenditures, 1916-17.—\$3,296.

Miscellaneous Identification of Grasses:

Object.—To identify grasses sent in from various sources.

Procedure.—Specimens are identified as they come in and reports made on them in different forms, depending upon the character of the work.

Cooperation.—National Herbarium.

Location.—Washington, D. C.

Date begun.—1868.

Results.—Miscellaneous identifications during 1915 numbered 5,657 specimens.

Assignment.—A. S. Hitchcock, Agnes Chase.

Proposed expenditures, 1916-17.—\$1,821.

Total, Botany of Economic Grasses, \$8,384, including \$1,684 statutory.

SYSTEMATIC WORK IN ECONOMIC BOTANY.**Economic Collections:**

Object.—To preserve and identify plants and plant products.

Procedure.—Specimens of plants are collected at the Arlington Farm and the several trial stations of the Bureau of Plant Industry. Material is also secured from other sources, including nurseries and seedmen's trial grounds. An herbarium is maintained in order to make the acquired information readily accessible and available.

Economic Collections—Continued.*Location.*—Washington, D. C.*Date begun.*—1907.*Results.*—During the past year about 1,000 specimens were added to the herbarium. A card index of desiderata is in preparation, which will include cultivated plants not already in the collection. The herbarium now contains 45,752 specimens.*Assignment.*—P. L. Ricker.*Proposed expenditures, 1916-17.*—\$1,640.**Economic Monograph of the Heather and Blueberry Families, with Special Reference to Their Utilization in the United States:***Object.*—Domestication of the blueberry and other plants of these families.*Procedure.*—Blueberry hybrids are propagated from specially selected wild stocks by new methods in the greenhouse, and field tests of these are made at a cooperative plantation in New Jersey. Plants propagated by cuttings from some of the best selected hybrids will ultimately be distributed to private individuals throughout the country, in suitable locations, for trial.*Cooperation.*—Blueberry growers.*Location.*—Washington, D. C., New England, New Jersey, and Indiana.*Date begun.*—1908.*Results.*—Practical information to the present date has been embodied in Department Bulletin 334, "Directions for Blueberry Culture, 1916." Besides continuing the cooperative field plantation in New Jersey, another experiment has been started at East Wareham, Mass., in cooperation with the Massachusetts Agricultural Experiment Station.*Probable date of completion.*—1925.*Assignment.*—Frederick V. Coville.*Proposed expenditures, 1916-17.*—\$1,766.**Systematic Botany of the Forage Plants Cultivated in America, Exclusive of the Grasses:***Object.*—To publish taxonomic information on plants cultivated for forage in the United States.*Procedure.*—Material is collected at the Arlington Farm, Va., and other experiment stations where various species of forage plants are in cultivation. Studies of the material are conducted in the field and in the herbarium.*Location.*—Washington, D. C.*Date begun.*—1910.*Results.*—Many identifications have been made and assistance furnished to forage-plant breeders and experimenters.*Probable date of completion.*—1918.*Assignment.*—P. L. Ricker.*Proposed expenditures, 1916-17.*—\$1,000.**Ornamental Trees and Shrubs in the American Nursery Trade:***Object.*—To devise an accurate classification for these plants.*Procedure.*—Material of the class indicated growing in nurseries, parks, trial grounds, and private estates is collected, and this material, both in the living state and in the herbarium, is studied.*Cooperation.*—Nurserymen.*Location.*—Washington, D. C., and various parts of the United States.*Date begun.*—1910.*Results.*—Assistance has been rendered to nurserymen and horticulturists in matters relating to this subject.*Assignment.*—P. L. Ricker.*Proposed expenditures, 1916-17.*—\$1,400.**Monograph of the Grossulariaceæ, with Special Reference to the Species Useful in the United States:***Object.*—To accurately classify American gooseberries and currants.*Procedure.*—Living plants and herbarium material are collected and studied, with the view of securing suitable stocks for cultivation and for plant breeding.*Location.*—Washington, D. C.*Date begun.*—1907.*Results.*—Work for the present is confined to the accumulation of data through the receipt and identification of specimens.*Assignment.*—Frederick V. Coville.*Proposed expenditures, 1916-17.*—No allotment; work incidental to other projects.

Records of the Origin and Character of Varieties of Ornamental Plants Originating under Cultivation:

Object.—To secure uniformity of nomenclature and accuracy of description in trade catalogues.

Procedure.—An index is kept of the cultivated plants offered in nurserymen's and seedsmen's catalogues.

Cooperation.—Horticulturists.

Location.—Washington, D. C.

Date begun.—1908.

Results.—An index of varieties of plants is maintained, which is much used by various offices of the department and in answering inquiries of department correspondents. A large addition to the collection of horticultural trade catalogues between the years 1875 and 1900 has been made. Photographic copies have been made of about a dozen trade catalogues issued between 1724 and 1800. These are particularly valuable as a means of tracing the history and date of trade introduction of certain plants. Circular letters have been sent to all horticulturists in the United States who issue catalogues, requesting back numbers not in our collection. An incident of this method of securing valuable historical material was the location and donation to the department of the manuscript of the first edition of Coxe's "View of the Cultivation of Fruits in America," published in 1817, containing notes intended for a second edition and also a set of unpublished colored drawings of the American fruits of that time.

Assignment.—P. L. Ricker.

Proposed expenditures, 1916-17.—\$1,400.

Miscellaneous Identifications:

Object.—To identify plant material submitted by agricultural and horticultural workers and from various other sources.

Cooperation.—Forest Service, various State stations, and correspondents.

Location.—Washington, D. C.

Date begun.—1868.

Results.—During 1915, 4,199 miscellaneous identifications were made, a large proportion being for the Forest Service.

Assignment.—P. L. Ricker, Ivar Tidestrom.

Proposed expenditures, 1916-17.—\$2,263.

Total, Systematic Work in Economic Botany, \$9,469, including \$2,719 statutory.

Total, Investigations in Economic and Systematic Botany, \$34,560, including \$10,560 statutory.

[Research.]

DRY-LAND AGRICULTURE INVESTIGATIONS.

SUPERVISION.

Supervision:

Object.—To supervise the maintenance of field stations and direct the agricultural work in dry-land areas of the Great Plains region, furnish facilities for investigational activities of other bureaus and offices of the department, and conduct the necessary routine work in connection with this project group.

Cooperation.—Experiment stations of Montana, North Dakota, Nebraska, Kansas, and New Mexico, and the Forest Service. (Independent stations, not in cooperation with State experiment stations, are maintained at Ardmore, S. Dak., Mandan, N. Dak., Big Spring and Dalhart, Tex., Akron, Colo., Tucumcari, N. Mex., and Lawton and Woodward, Okla.)

Location.—Main headquarters, Washington, D. C.; field headquarters, Denver, Colo.

Date begun.—1905.

Assignment.—E. C. Chilcott, J. S. Cole.

Proposed expenditures, 1916-17.—\$30,020, including \$4,420 statutory.

INVESTIGATIONS AT INDEPENDENT FIELD STATIONS.

Akron (Colo.) Field Station:

Object.—To determine the best methods of soil cultivation and crop rotations for the conservation of moisture and the maintenance of humus in the soil of the Great Plains area.

Akron (Colo.) Field Station—Continued.

Procedure.—This station and the Ardmore, Big Spring, Dalhart, Lawton, Mandan, Tucumcari, Woodward, and Sheridan field stations are operated independently by the Office of Dry-Land Agriculture Investigations. An assistant in dry-land agriculture (who is the superintendent) is detailed to this station during the growing season. The superintendent has full charge of, and is held responsible for, all the details of the cooperative work between this office and the various cooperating offices of the Bureau of Plant Industry and other bureaus. He attends personally, with the aid of his assistants, to taking soil samples, making moisture determinations, taking meteorological observations, etc. He supervises, takes notes, and keeps records of the preparation, seeding, tillage, and harvesting dates, thrashing, weighing, and measuring of all crops grown on the cooperative plats. He is expected to provide facilities, such as land, tools, common labor, and office and laboratory space, for the cooperating offices. During the winter months the assistant spends his time in the Washington office preparing the notes of the season's work for the permanent records or for publication. Complete records of all the cooperative work are kept both at the station and at the Washington office, where they are open to the inspection of the public at all times.

Cooperation.—Forest Service, Citizens' Association of Akron, Colo., and the County Commissioners of Washington County, Colo.

Location.—About 4 miles from Akron, Colo.

Date begun.—1907.

Results.—The results obtained through the experimental work being carried on at this station have been published in Department Bulletins 214, 218, 219, 222, 253, and 268.

Assignment.—O. J. Grace.

Proposed expenditures, 1916-17.—\$10,000.

Ardmore (S. Dak.) Field Station:

Object.—Same as Akron field station.

Procedure.—Same as Akron field station.

Cooperation.—Private individuals.

Location.—About 2 miles from Ardmore, S. Dak.

Date begun.—1911.

Results.—The results obtained through the experimental work being carried on at this station have been published in Department Bulletins 214, 218, 219, 222, and 268.

Assignment.—F. L. Kelso.

Proposed expenditures, 1916-17.—\$10,000.

Big Spring (Tex.) Field Station:

Object.—Same as Akron station.

Procedure.—Same as Akron station.

Cooperation.—Private individuals.

Location.—One mile from Big Spring, Tex.

Date begun.—1914.

Results.—Cropping operations were begun in the summer of 1914; too early to formulate definite results.

Assignment.—J. E. Mundell.

Proposed expenditures, 1916-17.—\$8,000.

Dalhart (Tex.) Field Station:

Object.—Same as Akron station.

Procedure.—Same as Akron station.

Cooperation.—Dalhart Fair Association, Dalhart, Tex., and the Forest Service.

Location.—Three miles from Dalhart, Tex.

Date begun.—1907.

Results.—Published in Department Bulletins 214, 218, 219, 222, 242, and 268.

Assignment.—W. D. Griggs.

Proposed expenditures, 1916-17.—\$8,000.

Lawton (Okla.) Field Station:

Object.—Same as Akron station.

Procedure.—Same as Akron station.

Cooperation.—Office of Indian Affairs, Department of the Interior.

Location.—One mile from Lawton, Okla.

Date begun.—1915.

Lawton (Okla.) Field Station—Continued.

Results.—Cropping operations were started in March, 1915; too early to formulate definite results.

Assignment.—W. M. Osborn.

Proposed expenditures, 1916-17.—\$8,000.

Mandan (N. Dak.) Field Station:

Object.—To assemble, test, develop, propagate, and distribute trees, shrubs, and other plants adapted to the climate and soil of the semiarid lands of the United States, and to demonstrate the value of these plants.

Procedure.—Same as Akron station.

Cooperation.—North Dakota Experiment Station and the Forest Service.

Location.—About 1 mile from Mandan, N. Dak.

Date begun.—1913.

Results.—Extensive experiments have been undertaken in connection with staple crops, forage crops, horticultural plantings, ornamental trees, climatic and meteorological studies, etc., but the work has not been carried on over a sufficient length of time to warrant publication.

Assignment.—W. A. Peterson, J. T. Sarvis, M. Pfaender, Robert Wilson, A. W. Schulz.

Proposed expenditures, 1916-17.—\$29,500.

Tucumcari (N. Mex.) Field Station:

Object.—Same as Akron station.

Procedure.—Same as Akron station.

Cooperation.—Agricultural College of New Mexico.

Location.—Two miles from Tucumcari, N. Mex.

Date begun.—1911.

Results.—The results obtained through the experimental work being carried on at this station have been published in Department Bulletins 214, 218, 219, 222, 242, and 268.

Assignment.—H. G. Smith.

Proposed expenditures, 1916-17.—\$7,000.

Woodward (Okla.) Field Station:

Object.—Same as Akron station.

Procedure.—Same as Akron station.

Location.—Two miles from Woodward, Okla.

Date begun.—1914.

Results.—Cropping operations were started during the season of 1914; too early to formulate definite results.

Assignment.—E. F. Chilcott.

Proposed expenditures, 1916-17.—\$9,200.

Sheridan (Wyo.) Field Station:

Object.—Same as Akron station.

Procedure.—Same as Akron station.

Cooperation.—Wyoming Board of Farm Commissioners; other offices in the Bureau of Plant Industry.

Location.—About 7 miles from Sheridan, Wyo.

Date begun.—April, 1916.

Results.—Too early to formulate results.

Assignment.—L. D. Willey.

Proposed expenditures, 1916-17.—\$10,000.

Total, Investigations at Independent Field Stations, \$99,700, including \$2,700 statutory.

INVESTIGATIONS IN COOPERATION WITH BUREAU OF PLANT INDUSTRY OFFICES.**Amarillo (Tex.) Field Station:**

Object.—To determine the best methods of soil cultivation and crop rotations for the conservation of moisture and the maintenance of humus in the soil of the Great Plains area.

Procedure.—This station and the Archer, Belle Fourche, Huntley, and Scotts-bluff field stations are operated by other offices of the Bureau of Plant Industry, which afford facilities for investigations in dry-land agriculture. An assistant in dry-land agriculture is detailed to this station during the growing season. He has full charge of, and is held responsible for, all the details of the dry-land

Amarillo (Tex.) Field Station—Continued.

agriculture investigations being carried on at the station. He attends personally, with such help from unskilled laborers as they can give, to the taking of soil samples, making moisture determinations, taking meteorological observations, etc. He supervises, takes notes, and keeps records of the preparation, seeding, tillage, and harvesting dates, thrashing, weighing, and measuring of all crops grown on the dry-land plats. The superintendent of the station is expected to provide facilities, such as the necessary land for the experimental plats, tools, common labor, and office and laboratory space for the work. During the winter months the assistant spends his time in the Washington office preparing the notes of the season's work for the permanent records or for publication. Complete records of all the cooperative work are kept both at the station and at the Washington office, where they are open to the inspection of the public at all times.

Location.—About 1½ miles from Amarillo, Tex.

Date begun.—1906.

Results.—The results obtained through the experimental work being carried on at this station have been published in Department Bulletins 214, 218, 219, 222, 242, and 268.

Assignment.—L. N. Jensen.

Proposed expenditures, 1916-17.—\$2,000.

Archer (Wyo.) Field Station:

Object.—Same as Amarillo station.

Procedure.—Same as Amarillo station.

Location.—About 1 mile from Archer, Wyo.

Date begun.—1913.

Results.—Cropping operations were started in the spring of 1913; too early to formulate definite results.

Assignment.—L. D. Willey.

Proposed expenditures, 1916-17.—\$2,500.

Belle Fourche (S. Dak.) Field Station:

Object.—Same as Amarillo station.

Procedure.—Same as Amarillo station.

Location.—Two miles from Newell, S. Dak.

Date begun.—1907.

Results.—The results obtained through the experimental work being carried on at this station have been published in Department Bulletins 214, 218, 219, 222, 242, and 268.

Assignment.—O. R. Mathews.

Proposed expenditures, 1916-17.—\$2,800.

Huntley (Mont.) Field Station:

Object.—Same as Amarillo station.

Procedure.—Same as Amarillo station.

Location.—One-half mile from Huntley, Mont.

Date begun.—1909.

Results.—The results obtained through the experimental work being carried on at this station have been published in Department Bulletins 214, 218, 219, 222, 242, and 268.

Assignment.—A. E. Seamans.

Proposed expenditures, 1916-17.—\$3,000.

Scottsbluff (Nebr.) Field Station:

Object.—Same as Amarillo station.

Procedure.—Same as Amarillo station.

Location.—Six miles from Scottsbluff, Nebr.

Date begun.—1909.

Results.—The results obtained through the experimental work being carried on at this station have been published in Department Bulletins 214, 218, 219, 222, 242, and 268.

Assignment.—J. H. Jacobson.

Proposed expenditures, 1916-17.—\$3,000.

**Total, Investigations in Cooperation with Bureau of Plant Industry Offices,
\$13,300.**

INVESTIGATIONS IN COOPERATION WITH STATE STATIONS.

Colby (Kans.) Field Station:

Object.—To determine the best methods of soil cultivation and crop rotations for the conservation of moisture and the maintenance of humus in the soil of the Great Plains area.

Procedure.—This station and the Dickinson, Edgeley, Garden City, Havre, Hays, Hettinger, Judith Basin, North Platte, and Williston field stations are located at State experiment substations, which afford the department facilities for investigations in dry-land agriculture. An assistant in dry-land agriculture is detailed to this station during the growing season. He has full charge of, and is held responsible for, all the details of the dry-land agriculture investigations being carried on at the station. He attends personally, with such help from unskilled laborers as they can give, to the taking of soil samples and the making of moisture determinations and keeps records of the preparation, seeding, tillage, and harvesting dates, thrashing, weighing, and measuring of all crops grown on the dry-land plats. The superintendent of the station is expected to provide facilities, such as the necessary land for the experimental plats, tools, common labor, and office and laboratory space for the work. During the winter months the assistant spends his time in the Washington office preparing the notes of the season's work for the permanent records or for publication. Complete records of all the cooperative work are kept both at the station and at the Washington office, where they are open to the inspection of the public at all times.

Cooperation.—Kansas Experiment Station.

Location.—One mile from Colby, Kans.

Date begun.—1914.

Results.—Cropping operations were started in 1914; too early to formulate definite results.

Assignment.—J. B. Kuska.

Proposed expenditures, 1916-17.—\$2,300.

Dickinson (N. Dak.) Field Station:

Object.—Same as Colby station.

Procedure.—Same as Colby station.

Cooperation.—North Dakota Experiment Station.

Location.—One mile from Dickinson, N. Dak.

Date begun.—1906.

Results.—Data obtained through the experimental work at this station have been published in Department Bulletins 214, 218, 219, 222, and 268, and also in one bulletin of the North Dakota Experiment Station.

Assignment.—J. C. Thysell.

Proposed expenditures, 1916-17.—\$2,500.

Edgeley (N. Dak.) Field Station:

Object.—Same as Colby station.

Procedure.—Same as Colby station.

Cooperation.—North Dakota Experiment Station and the Forest Service.

Location.—One mile from Edgeley, N. Dak.

Date begun.—1905.

Results.—Data on the experimental work carried on at this station have been published in Department Bulletins 214, 218, 219, 222, and 268, and also in one bulletin of the North Dakota Experiment Station.

Assignment.—R. S. Towle.

Proposed expenditures, 1916-17.—\$2,500.

Garden City (Kans.) Field Station:

Object.—Same as Colby station.

Procedure.—Same as Colby station.

Cooperation.—Kansas Experiment Station.

Location.—Four miles from Garden City, Kans.

Date begun.—1906.

Results.—The results obtained through the experimental work being carried on at this station have been published in Department Bulletins 214, 218, 219, 222, 242, and 268.

Assignment.—C. B. Brown.

Proposed expenditures, 1916-17.—\$2,300.

Havre (Mont.) Field Station:

Object.—Same as Colby station.

Procedure.—Same as Colby station.

Cooperation.—Montana Experiment Station.

Location.—Seven miles from Havre, Mont.

Date begun.—1915.

Results.—This work has just begun.

Assignment.—G. W. Morgan.

Proposed expenditures, 1916-17.—\$2,100.

Hays (Kans.) Field Station:

Object.—Same as Colby station.

Procedure.—Same as Colby station.

Cooperation.—Kansas Experiment Station.

Location.—One-half mile from Hays, Kans.

Date begun.—1906.

Results.—The results obtained through the experimental work being carried on at this station have been published in Department Bulletins 214, 218, 219, 222, 242, and 268.

Assignment.—A. L. Hallsted.

Proposed expenditures, 1916-17.—\$2,500.

Hettinger (N. Dak.) Field Station:

Object.—Same as Colby station.

Procedure.—Same as Colby station.

Cooperation.—North Dakota Experiment Station.

Location.—One-half mile from Hettinger, N. Dak.

Date begun.—1910.

Results.—Data obtained through the experimental work at this station have been published in Department Bulletins 214, 218, 219, 222, and 268, and also in one bulletin of the North Dakota Experiment Station.

Assignment.—A. J. Ogaard.

Proposed expenditures, 1916-17.—\$2,500.

Judith Basin (Mont.) Field Station:

Object.—Same as Colby station.

Procedure.—Same as Colby station.

Cooperation.—Montana Experiment Station.

Location.—One mile from Judith Basin, Mont.

Date begun.—1907.

Results.—Data obtained through the experimental work at this station have been published in Department Bulletins 214, 218, 219, 222, and 268.

Assignment.—J. M. Stephens.

Proposed expenditures, 1916-17.—\$2,400.

North Platte (Nebr.) Field Station:

Object.—Same as Colby station.

Procedure.—Same as Colby station.

Cooperation.—Nebraska Experiment Station.

Location.—Two miles from North Platte, Nebr.

Date begun.—1906.

Results.—Data obtained through the experimental work at this station have been published in Department Bulletins 214, 218, 219, 222, and 268.

Assignment.—L. L. Zook.

Proposed expenditures, 1916-17.—\$2,700.

Williston (N. Dak.) Field Station:

Object.—Same as Colby station.

Procedure.—Same as Colby station.

Cooperation.—North Dakota Experiment Station.

Location.—One-half mile from Williston, N. Dak.

Date begun.—1908.

Results.—Data obtained through the experimental work at this station have been published in Department Bulletins 214, 218, 219, 222, and 268, and also in one bulletin of the North Dakota Experiment Station.

Assignment.—C. H. Ruzicka.

Proposed expenditures, 1916-17.—\$2,300.

Total, Investigations in Cooperation with State Stations, \$24,100.

Total, Dry-Land Agriculture Investigations, \$167,120, including \$7,120 statutory.

[Research.]

WESTERN IRRIGATION AGRICULTURE INVESTIGATIONS.

SUPERVISION.

Supervision:

Object.—To maintain field stations and supervise agricultural work on irrigated and other lands in the arid and semiarid regions of the western United States and to conduct routine office business in connection therewith.

Procedure.—Eight field stations are operated in the arid and semiarid regions of the West for the purpose of investigating agricultural conditions, studying and devising methods of crop production, and providing the various cooperating offices of the bureau with facilities for carrying on their special lines of investigation in the field. Each station is under the immediate supervision of a farm superintendent, who, with his assistants, attends to all the general and technical work, such as the taking of notes on the behavior of crops under different treatments, making moisture determinations, recording meteorological observations, the supervision of the cultural and harvesting operations connected with the experimental work, recording all notes on operations, crop yields, labor cost, etc. The superintendent also provides such facilities as land, teams, common labor, and office and laboratory supplies for the use of cooperating offices of the bureau.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—C. S. Scofield.

Proposed expenditures, 1916-17.—\$19,834, including \$7,780 statutory.

CROP PRODUCTION UNDER IRRIGATION.

Yuma (Ariz.) Field Station:

Object.—To develop agricultural methods under irrigation.

Procedure.—See project, "Supervision."

Location.—Near Bard, Cal.

Date begun.—1906.

Results.—The work at Yuma during the past year developed more rapidly than during any previous year. The soil-improvement work of recent years has resulted in a gradually increased effectiveness of the field-crop experiments that are in progress. A new method of planting cotton was inaugurated, the cotton being planted with wide beds between each pair of two rows. The preliminary results indicate that this method may become practicable in the production of cotton on irrigated lands. Tests of deciduous fruits were continued and somewhat extended. The trees have made unusual growth considering the peculiar climatic conditions of the locality.

Assignment.—R. E. Blair, C. E. Peterson.

Proposed expenditures, 1916-17.—\$11,900.

Truckee-Carson (Nev.) Field Station:

Object.—To determine crop varieties and agricultural methods most suitable to successful farming on the Truckee-Carson Reclamation Project.

Procedure.—Same as at Yuma station.

Location.—Near Fallon, Nev.

Date begun.—1906.

Results.—The work of the farm progressed satisfactorily during the past year. The drainage system on field "Y" was placed in operation and a comprehensive series of experiments in the reclamation of alkali soils inaugurated. Satisfactory results were secured in the crop-testing work conducted on 12 farms in cooperation with the Office of Demonstrations on Reclamation Projects. These tests were devoted chiefly to crops for use in supplementing alfalfa as a feed for live stock and included corn, wheat, barley, and mangels. The results were particularly promising with respect to corn and mangels.

Assignment.—F. B. Headley, E. W. Curtis.

Proposed expenditures, 1916-17.—\$10,320.

San Antonio (Tex.) Field Station:

Object.—To determine new and standard crops and agricultural methods adapted to successful farming in the vicinity of San Antonio, Tex.

Procedure.—Same as at Yuma station.

Location.—Near San Antonio, Tex.

Date begun.—1903.

San Antonio (Tex.) Field Station—Continued.

Results.—The work at this station as outlined in previous reports was continued. Satisfactory progress was made in the rotation and tillage experiments. The crop yields secured were higher in all cases, except cotton and milo, than the average yields for the six-year period beginning in 1909. The results of these experiments in 1915 indicate the desirability of plowing previous to January 1 of the year in which the crops are to be planted, particularly where cotton or corn is to follow sorghum. The use of barnyard manure has had a more favorable effect on cotton than on other crops. Some valuable preliminary results were secured regarding the control of root-rot, which seriously damages many crops in the San Antonio region. It was found that root-rot did more damage in continuously cropped fields than in fields where crop rotation was practiced and that it was more damaging to the cotton crop on spring-plowed land than on fall-plowed land.

Assignment.—R. M. Meade, C. R. Letteer.

Proposed expenditures, 1916-17.—\$10,256.

Scottsbluff (Nebr.) Field Station:

Object.—To determine crop varieties and agricultural methods most suitable to successful agriculture on the irrigated lands of the region.

Procedure.—Same as at Yuma station.

Cooperation.—Nebraska Experiment Station.

Location.—Near Mitchell, Nebr.

Date begun.—1909.

Results.—In the rotation experiments the results continue to show very markedly the beneficial effects of including alfalfa and of using barnyard manure in the cropping systems. Somewhat better yields of sugar beets have been secured in rotations including alfalfa and on land to which barnyard manure has been applied. In both instances the yields were markedly higher than those secured by other methods. Excellent results were secured by seeding alfalfa on oat stubble in the late summer, indicating that by practicing this method the farmers can materially increase the yields of their newly planted alfalfa during the first year. The pasture-grass and pasture-carrying capacity experiments were continued and extended and satisfactory results secured.

Assignment.—Fritz Knorr, J. A. Holden.

Proposed expenditures, 1916-17.—\$7,540.

Umatilla (Oreg.) Field Station:

Object.—To determine crops and agricultural methods best adapted to successful farming on the sandy soils of the Umatilla Reclamation Project.

Procedure.—Same as at Yuma station.

Cooperation.—Forest Service and the Oregon Experiment Station.

Location.—Near Hermiston, Oreg.

Date begun.—1909.

Results.—One of the most important phases of the experimental work during the past year has had to do with methods of irrigation. The losses of water due to rapid percolation have been investigated and improved methods of application tested. It has been found that in order to secure the necessary efficiency in irrigation frequent and quick applications of water must be practiced. This necessitates improvements in the farm-irrigation systems. The results of these investigations are being placed before the farmers individually by a representative of the Office of Demonstrations on Reclamation Projects. In order to make a detailed study of water percolation in the sandy soils which characterize the project, a set of four lysimeters was installed and percolation tests inaugurated.

Assignment.—R. W. Allen, H. K. Dean.

Proposed expenditures, 1916-17.—\$3,000.

Huntley (Mont.) Field Station:

Object.—To determine crop varieties and agricultural methods most suitable to successful farming on the Huntley Reclamation Project.

Procedure.—Same as at Yuma station.

Cooperation.—Montana Experiment Station.

Location.—Near Huntley, Mont.

Date begun.—1909.

Results.—One of the most important results of the year related to tests with irrigated pastures. Carrying-capacity tests indicate that a well-managed irrigated pasture will carry at least two cows per acre. Additional pasture-mixture plantings were made, in which the practicability of using nurse crops was tested, and

Huntley (Mont.) Field Station—Continued.

satisfactory preliminary results were secured. An experiment conducted during the latter part of the season on spring-seeded pasture gave results indicating the desirability of using young stock for grazing newly planted pasture. Satisfactory results were again secured by pasturing alfalfa with hogs and by hogging corn. A return of \$75 per acre was secured from alfalfa pasture and \$60 per acre from corn. Negative results were again secured in the test of phosphatic fertilizers for oats, indicating that the fertilizer used has no important value on the soils of the Huntley Project.

Assignment.—Dan Hansen.

Proposed expenditures, 1916-17.—\$10,630.

Belle Fourche (S. Dak.) Field Station:

Object.—To determine crop varieties and agricultural methods most suitable for successful agriculture on the irrigated lands of the region.

Procedure.—Same as at Yuma station.

Cooperation.—Forest Service.

Location.—Near Newell, S. Dak.

Date begun.—1907.

Results.—The second year's results secured from the fall irrigation experiments, which were inaugurated in the fall of 1913 for the purpose of determining the effect of irrigating the land in the fall preceding spring planting of wheat, oats, barley, flax, potatoes, sugar beets, and corn, again failed to show any benefits from fall irrigation. These experiments are still in progress. Good progress was made in the irrigated rotation experiments, where the benefits of including alfalfa in the rotation and of using barnyard manure were particularly apparent. In the rotations where hogs were pastured on alfalfa and where corn was hogged a return of \$60.32 per acre was secured from alfalfa pasture and \$38.86 per acre from corn. The pasture-grass tests inaugurated in 1913 were continued, and some preliminary carrying-capacity determinations were satisfactorily made.

Assignment.—Beyer Aune.

Proposed expenditures, 1916-17.—\$10,000.

Lawton (Okla.) Field Station:

Object.—To inaugurate and supervise experiments with irrigated crops on the experiment farm maintained at Lawton, Okla., by the Office of Dry-Land Agriculture, for the purpose of determining crop varieties and agricultural methods most suitable to successful agriculture on the irrigated lands of the region.

Procedure.—It is proposed to place a field representative at the Lawton station, who will attend to the general technical work of these irrigated experiments, such as the taking of notes on the behavior of crops under different treatments, making moisture determinations, supervising the cultural and harvesting operations connected with the work, recording all notes on operations, crop yields, labor cost, etc. This work will be conducted in cooperation with the Office of Dry-Land Agriculture.

Location.—Near Lawton, Okla.

Date begun.—July 1, 1916.

Assignment.—Assistant to be appointed.

Proposed expenditures, 1916-17.—\$5,000.

Total, Crop Production under Irrigation, \$68,646, including \$5,820 statutory.

SOUTHWESTERN COTTON CULTURE.**Introduction of Commercial Cotton Culture in the Southwest:**

Object.—To introduce into commercial culture in the arid Southwest profitable strains of long-staple cottons bred and acclimated to meet local conditions.

Procedure.—This work has been carried on by the committee on southwestern cotton culture through a field representative working in direct cooperation with growers and marketing organizations. Cooperation is had with the Offices of Alkali and Drought Resistant Plant-Breeding Investigations, Crop Physiology and Breeding Investigations, and Crop Acclimatization and Adaptation and Cotton-Breeding Investigations, within the Bureau of Plant Industry.

Cooperation.—Office of Markets and Rural Organization.

Location.—Southern Arizona and southern California.

Date begun.—1906.

Introduction of Commercial Cotton Culture in the Southwest—Continued.

Results.—Financial cooperation in this work during the past fiscal year was limited to the employment of one field representative to superintend roguing work. The acreage of cotton in the Salt River Valley was materially reduced, owing to the low prices prevailing. The organization of the industry continued, however, in a very satisfactory manner.

Probable date of completion.—The promotion work in connection with the establishment of this industry is gradually drawing to a conclusion, and the expenditures will be reduced during the present fiscal year. It will be necessary for the department to continue some of its work in cooperation with the growers' associations for several years longer. This work will have to do chiefly with the improvement of the varieties to be used by the farmers, and with the supervision of field roguing, in order to secure ample supplies of carefully selected seed for planting.

Assignment.—C. S. Scofield.

Proposed expenditures, 1916-17.—\$500.

Total, Western Irrigation Agriculture Investigations, \$88,980, including \$13,600 statutory.

[Research.]

POMOLOGICAL INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—General administration and direction of the research projects and necessary incidental clerical work.

Cooperation.—Other offices within the department.

Location.—Washington, D. C.

Date begun.—1886.

Assignment.—L. C. Corbett, H. P. Gould.

Proposed expenditures, 1916-17.—\$13,047, including \$5,927 statutory.

FRUIT HANDLING AND STORAGE INVESTIGATIONS.**Fruit Handling and Storage:**

Object.—To determine the factors governing the successful handling, transportation, and storage of fruits, and to demonstrate methods in harvesting, transportation, and storage whereby decay, deterioration, and loss in transit, in storage, and at market terminals may be reduced to a minimum.

Procedure.—Studies are made of the cultural, soil, climatic, and other factors affecting the keeping quality of fruits; of the handling methods employed in harvesting and preparing the fruits for shipment; of the handling methods in transportation, at market terminals, and in storage warehouses; as well as of the relation of transportation and warehouse facilities to keeping quality. The investigations are carried on, so far as practicable, in those regions where the handling, transportation, or storage problems are most acute. The fruit and the facilities of the district are made use of in order to determine the factors in the chain of events in the life history of the fruit which cause loss or deterioration. To determine the factors influencing the shipping quality of fruit experimental lots are picked, packed, and shipped under the direction of bureau representatives in comparison with comparable lots of fruit handled according to the ordinary commercial methods of the region. To secure exact temperature records of fruit in transit bureau representatives accompany the shipments from point of origin to destination.

Products used for precooling investigations are selected, picked, packed, and handled by bureau representatives in the same general way as those intended for shipment or for storage, pre-cooled lots being checked up by comparable non-precooled material. Temperature records in transit are obtained by bureau representatives who have accompanied the shipment. The condition of the product on and after arrival is determined by inspectors temporarily stationed at the receiving points for that purpose. The behavior of fruits in storage is determined by frequent periodic inspections by bureau representatives of samples withdrawn from storage, whether cold or common, for that purpose. The work is so distributed throughout the country as to cover, so far as practicable, regional factors which influence the methods of handling, storing, and shipment, as well as the behavior of varieties.

Fruit Handling and Storage—Continued.

Cooperation.—Office of Markets and Rural Organization, Bureau of Chemistry, fruit growers' associations and exchanges, individual growers, independent shippers, railway companies, refrigerator-car lines, storage warehouses, and fruit receivers.

Location.—Field work in Florida, Georgia, Louisiana, Colorado, Idaho, Montana, Washington, Oregon, California, Arizona, Texas, Arkansas, Illinois, Michigan, New York, Indiana, Maine, Pennsylvania, Massachusetts, Virginia, West Virginia, Maryland, and North Carolina, with inspections at New York, Boston, Philadelphia, Pittsburgh, Chicago, Washington, D. C., Portland, Oreg., North Yakima, Wash., Denver, Colo., Watsonville, Cal., and other fruit-market centers.

Date begun.—1901.

Results.—The factors involved in the successful handling of fruit for, and in, transportation and storage have been determined, especially with oranges, lemons, grapes, and berries in California; oranges, grapefruit, and pineapple in Florida; strawberries in Louisiana and Arkansas; apples, pears, and berries in Oregon, Washington, Montana, Idaho, and California; peaches in Georgia, Texas, and Washington; and apples and pears in the Atlantic and Middle-Western States. The results have been made available to the different industries through actual demonstrations in the fields, market centers, and storage warehouses, resulting in marked improvement in handling methods and in the keeping quality of the fruit. Data published in Bureau of Plant Industry Bulletins 40, 48, 108, and 123, Department Bulletins 35, 63, 274, and 331, and Farmers' Bulletin 696; also in Department Yearbook articles, Bureau of Plant Industry circulars, field circulars, and miscellaneous papers and addresses. Publications dealing with the common storage and the cold storage of apples, the precooling of oranges in Florida, and the temperatures of fruit in transit have been prepared and submitted for publication. Other publications are in course of preparation.

Assignment.—H. J. Ramsey, S. J. Dennis, C. W. Mann, E. L. Markell, William E. Mosher, H. S. Bird, E. D. Vosbury, William C. Quick, V. W. Ridley, George L. Fischer, J. F. Fernald.

Proposed expenditures, 1916-17.—\$40,560, including \$4,060 statutory.

VITICULTURAL INVESTIGATIONS.**Vinifera Grapes:**

Object.—To determine the relative adaptability of resistant grape stocks, direct producers, and Vinifera grape varieties to soil types and climatic and other conditions; to study the relative congeniality of grape varieties to different resistant stocks; to investigate the adaptability of the Vinifera to soil types and climatic and other conditions in regions not infested with phylloxera; when necessary, to develop resistant direct producers valuable for the several purposes and suited to the different conditions in this country; to determine the uses of grape varieties; to find the best methods of propagating, grafting, planting, cultivating, pruning, and training grape varieties in different environments, and to discover, develop, and disseminate valuable grape varieties.

Procedure.—Studies are made of resistant stocks, direct producers, Vinifera and other Euvitis, and Euvitis grafted on resistant stocks now planted under a wide range of soil, climatic, and other conditions in experiment and commercial vineyards. Studies are made of the relative value of grape varieties for the different uses, their relative adaptability, vigor of growth, and ability to endure and resist drought, alkali, etc., as well as phylloxera and the various vine diseases. Special investigations of various viticultural problems presenting themselves are pursued in the department's experiment vineyards.

Cooperation.—Vineyardists and vineyard companies in California.

Location.—Washington, D. C., and cooperative experiment vineyards located at Brawley, Colfax, Chico, Elk Grove, Fresno, Geyserville, Guasti, Lodi, Oakville, Sonoma, and Stockton, Cal.

Date begun.—1903.

Results.—The duplicate variety collections used upon resistant stocks in the several experiment vineyards is clearly demonstrating the sorts which are most advantageous for stocks under the altitudes, climatic and other conditions, and the soil types found in the department's different experiment vineyards. Extensive tests on a range of resistant-stock varieties of Euvitis varieties commercially grown in this country, as well as of a large number of varieties introduced by the department previously not grown or known in this country,

Vinifera Grapes—Continued.

are definitely demonstrating the combinations of stocks and varieties best adapted for commercial planting for different purposes and for the various vineyard regions. Through these tests the superior values and uses in commercial vineyards of a number of grape varieties heretofore not known in this country have been demonstrated. Various tests of the currant producing and of the Almerian storage and shipping grape varieties have given such encouraging results that a number of new pruning, training, and incision experiments are under way and arrangements are being made for extensive plantings of them to demonstrate their value as a commercial crop in this country.

During the vintage season a series of educational fresh-grape exhibits, representing clusters of 430 grape varieties, were made in the Agricultural Palace, the Horticultural Palace, and the Food Products Building of the Panama-Pacific International Exposition. These were awarded the grand prize for educational fruit exhibits. Through them more publicity was given the department's viticultural investigations than they have otherwise had throughout their existence. Clusters of 64 grape varieties were sent from the department's experiment vineyard at Guasti, Cal., to the Dry-Land Congress at Denver, Colo.

Results to 1909 were published in Bureau of Plant Industry Bulletin 172; results since that time to 1915 in Department Bulletin 209; data also shown to date in annual reports of the chief of the Bureau of Plant Industry. Department Bulletin 349, "The Raisin Industry of the United States," was issued during the past year.

Assignment.—George C. Husmann, Fred L. Husmann, Elmer Snyder.

Proposed expenditures, 1916-17.—\$10,540.

Muscadine or Rotundifolia Grapes:

Object.—To investigate methods of propagating, grafting, planting, pruning, spraying, cultivating, fertilizing, and growing Muscadine grapes; to determine the range and adaptability of known varieties; to originate and develop better Muscadine varieties and hybrids of them and other species with larger clusters and better adherence of berry to pedicle, of higher sugar and lower acid content, and with perfect self-fertile flowers, etc.; and to determine best methods of harvesting, handling, and utilizing the fruit.

Procedure.—Field studies of vineyards and vines throughout the Muscadine regions are made. All promising varieties are assembled into a comprehensive collection for observation and testing to determine their relative values. Tests in the experiment vineyard and in the commercial vineyard are conducted to ascertain the best methods of trellising, pruning, training, spraying, pollenizing, cultivating, fertilizing, and growing Muscadine grapes. Breeding investigations are conducted in the experiment vineyard.

Cooperation.—North Carolina Department of Agriculture and private individuals.

Location.—Washington, D. C., Willard, N. C., and commercial vineyards throughout Muscadine regions.

Date begun.—1905.

Results.—It has been demonstrated that the commercial Muscadine varieties are practically self-sterile, that insects are the chief agencies of cross-pollination, and that interplanting of male vines is necessary. The breeding work has developed many desirable types, including self-fertile forms and hybrids with *Vinifera* and American *Euvitis* species. Approximately 6,000 seedlings have been produced and are under tests. It has been demonstrated that pruning is necessary for best fruiting results and that good results can be obtained by growing Muscadines upon a vertical trellis. General progress has been made along other lines. Seventeen colored transparencies illustrating the department's work with Muscadines were exhibited at the Panama-Pacific International Exposition. Results to 1911 are published in Bureau of Plant Industry Bulletin 273; results to date are shown in annual reports of Chief of Bureau. Farmers' Bulletin No. 709 on Muscadine grapes is about to be issued.

Assignment.—George C. Husmann, Charles Dearing.

Proposed expenditures, 1916-17.—\$3,035.

American Euvitis:

Object.—To investigate the relative adaptability of native American grapes and their hybrids to the soil and climatic conditions of the various grape-growing regions of the United States; to determine the value and uses of the several species and their hybrids in these regions; to ascertain the best methods of propagating, grafting, pruning, training, spraying, fertilizing, cultivating, and growing them; to develop and disseminate new and improved varieties; and to assist in reestablishing grape culture on a sound and rational basis.

American Euvitis—Continued.

Procedure.—This project involves field studies of the adaptability to soils, climates, and other conditions of native American grapes; studies of resistance to alkali, drought, moisture, heat, cold, diseases, insects, etc.; and researches to determine the value and uses of American Euvitis, their hybrids, and other species in commercial and experimental vineyards. Particular attention is given to methods of pruning, training, spraying, fertilizing, and culture.

Cooperation.—Vineyardists and vineyard companies in California and New Jersey.

Location.—Washington, D. C., Vineland, N. J., and Chico, Colfax, Fresno, Geyserville, Guasti, Oakville, and Sonoma, Cal.

Date begun.—1908.

Results.—Descriptions and illustrations have been made of a number of American grape varieties, and their value for dessert purposes and for the manufacture of unfermented juice determined. Valuable results are being obtained from tests of different methods of pruning, training, and fertilizing. Material for propagation of a number of rare, almost extinct varieties was received from various parties. Initial plantings of 106 varieties are being made in a varietal collection vineyard at the Arlington Farm. Greatly increased correspondence shows a general awakening of interest in viticultural matters of all kinds. Extensive exhibits of fruit of a number of American Euvitis and 18 colored transparencies illustrating some of the department's work with American Euvitis were shown at the Panama-Pacific International Exposition. Publications of results have appeared in annual reports of the chief of the bureau; in the Department Yearbook for 1904, "Some Uses of the Grapevine and Its Fruit"; Farmers' Bulletin 644, "Manufacture and Use of Unfermented Grape Juice"; and Farmers' Bulletin 471, "Grape Propagation, Pruning, and Training." A bulletin on American Euvitis is in course of preparation.

Assignment.—George C. Husmann, Fred L. Husmann, Charles Dearing.

Proposed expenditures, 1916-17.—\$3,190.

Total, Viticultural Investigations, \$16,765, including \$840 statutory.

FRUIT-PRODUCTION INVESTIGATIONS.**Fruit Production and Adaptation:**

Object.—To determine by field surveys and experiments the cultural factors limiting the production of deciduous and subtropical fruits in the several recognized, as well as prospective, fruit regions of the United States; and to secure records and information concerning the response (reaction) of cultivated fruits to the factors of climate and environment peculiar to these regions.

Procedure.—There are three main features of this investigation: (a) Propagation of fruits and nursery practices; (b) cultural methods and orchard technique, and (c) adaptability of varieties to environment, their suitability for specific purposes, and the geography of fruit growing. Because of the intimate relationships of these three factors of fruit production the work is prosecuted simultaneously.

Under (a) observations and experiments are made to determine the relative merits of different stocks congenial to the various fruits and adapted to the soil and environmental conditions of the various producing areas. General study is also made of the nursery practices followed in connection with the commercial multiplication of various species of fruits. Under (b) the details of the methods practiced by successful fruit growers operating under various conditions throughout the country are carefully observed and reported, in order to make available to those who for one reason or another are not conducting their cultural work in a manner most satisfactory from the standpoint of the varieties grown and the purpose for which the fruit is intended. Under (c) studies and records are made in connection with the influence of environmental conditions upon the behavior of varieties in the different sections for the purposes of determining the range of adaptability of the different sorts and of ascertaining those best suited for particular uses in a given locality. The geographic distribution of fruit growing, the factors which govern it, and the possibilities of extending commercial fruit growing in various localities are also given attention. Fruit plantations are maintained at the dry-land agriculture field station at Akron, Colo., and at the cereal field station at Amarillo, Tex., in connection with the fruit investigations in the Great Plains area.

Fruit Production and Adaptation—Continued.

Cooperation.—Fruit growers and nurserymen generally throughout the country.
Location.—Washington, D. C., Akron, Colo., Amarillo, Tex., and generally throughout the United States.

Date begun.—Some phases have been in progress since the organization of the Division of Pomology in 1886. The others have been taken up as conditions have made possible or the interests of the fruit industry have required.

Results.—Since the organization of the work on a project basis much information has been accumulated along all the lines. This is constantly drawn upon in answering a very large and ever-increasing volume of correspondence about fruit-production matters. The phenological data that have been assembled through the cooperation of fruit growers are frequently consulted by other offices and bureaus of the department and occasionally by experiment stations, as well as in connection with the pomological work. The publications issued include five Bureau of Plant Industry bulletins, one Bureau of Plant Industry circular, about 20 farmers' bulletins, and some 14 or more papers in the department yearbooks. Four manuscripts for farmers' bulletins have been submitted recently for publication and at least eight others are definitely projected with a view to their preparation during the fiscal year 1916-17. The data for one department bulletin on the adaptability of varieties have been compiled and are nearly ready for publication; material for another is in the course of preparation for publication.

Assignment.—H. P. Gould (deciduous tree fruits), Geo. M. Darrow (small fruits), L. B. Scott (tropical and subtropical fruits), W. F. Wight (nursery investigations), C. P. Close (phenological studies).

Proposed expenditures, 1916-17.—\$16,562, including \$2,200 statutory.

(Fruit-Culture Investigations: Discontinued as a separate project; included under "Fruit Production and Adaptation.")

(Cooperative Dry-Land Ranch Fruit-Garden Investigations: Discontinued as a separate project; included under "Fruit Production and Adaptation.")

(Nursery Investigations: Discontinued as a separate project; included under "Fruit Production and Adaptation.")

NUT-CULTURE INVESTIGATIONS.**Nut Culture:**

Object.—To determine the range of adaptability of different nuts, the relative value and merit of different varieties, their cultural requirements, and methods of propagation; and to produce improved varieties.

Procedure.—Nut growers, dealers, nurserymen, and private individuals.

Cooperation.—National Nut Growers' Association, Northern Nut Growers' Association, and nut growers and dealers throughout the United States.

Location.—Washington, D. C., Arlington Farm, Va., and nut-growing sections throughout the country.

Date begun.—About 1890.

Results.—During the year a questionnaire was sent to all regions where nuts grow indigenously, with the hope that new sorts of special merit for particular regions might be discovered. A number of promising ones, so far as the appearance of the nuts is concerned, have in this way been brought to the attention of the office. There has been a decided increase in the correspondence on nut culture. Farmers' Bulletin 700, "Pecan Culture," was issued during the year.

Assignment.—C. A. Reed.

Proposed expenditures, 1916-17.—\$3,690, including \$450 statutory.

FRUIT IMPROVEMENT THROUGH BREEDING, SELECTION, AND DOMESTICATION.

(Mississippi Valley Hardy-Fruit Breeding: Project discontinued. The Iowa Experiment Station has taken an option on the land upon which the extensive fruit-breeding experiments of Mr. C. G. Patten are being conducted, and are planning to secure an appropriation through the legislature for its purchase by the State.)

Fruit Improvement through Bud Selection:

Object.—To improve, through bud selection based on individual tree performance records, standard varieties of both citrus and deciduous fruits, special attention being given to oranges, lemons, and pomelos among the citrus, and apples, peaches, and pears among the deciduous; to investigate bud variability of standard citrus and deciduous fruits; to develop and introduce reliable practical methods for the selection of desirable parent trees for propagation purposes; to

Fruit Improvement through Bud Selection—Continued.

determine the various strains in standard varieties of citrus and deciduous fruits; and to standardize the quality and quantity of the product of the best strains by means of bud selection based on accurate individual tree performance records and observations.

Procedure.—Individual tree performance records are being made in a large number of citrus and deciduous fruit orchards in California, Michigan, and Connecticut, from which the relative value of the different strains of the varieties under investigation are being determined. The most valuable trees of the best strains are being used as sources of budwood, and progeny tests of these select trees are being made on an extensive scale. Through these progeny tests reliable sources of budwood of desirable strains will in this way be established.

Cooperation.—Citrus Experiment Station of the University of California, Michigan Agricultural College, and citrus and deciduous fruit growers.

Location.—Riverside, Cal., East Lansing, Mich., and South Glastonbury, Conn.

Date begun.—1910.

Results.—The first information regarding the value and importance of strains in citrus and deciduous fruit varieties was given the industry through the individual tree performance records. Commercial methods of keeping individual tree performance records have been worked out and are being extensively used by citrus and deciduous fruit growers to determine the inferior or drone trees in their orchards and to locate individual trees of special merit for sources of budwood. The value of fruit-bearing budwood for the propagation of standard commercial sorts has been demonstrated. Three citrus performance-record nurseries have been established in southern California.

A humidifier for the purpose of maintaining uniform conditions of humidity in storage rooms has been invented and is being used in several of the leading citrus storage warehouses in southern California. B. P. I. Circular 77, "Study of Improvement of Citrus Fruit through Bud Selection," has been issued. Bulletins giving the results of investigations for the improvement of the Valencia orange and for the improvement of the Washington Navel orange have been prepared for publication. Results of investigations for the improvement of the Eureka and Lisbon lemons, the Marsh Seedless pomelo, and the Dancy tangerine will be available for publication during the year 1916.

Assignment.—A. D. Shamel, C. S. Pomeroy, C. L. Dyer.

Proposed expenditures, 1916-17.—\$11,473.

Rosaceous-Fruit Breeding and Domestication:

Object.—To study the fundamental principles involved in the breeding of new and improved varieties of rosaceous fruits, and to produce varieties of improved intrinsic quality, hardiness, productiveness, and disease resistance in the different fruit-producing regions of the country.

Procedure.—Crosses and selections are being made between the most promising types of fruits in the several fruit-producing regions for the express purpose of securing, if possible, varieties capable of enduring or overcoming certain extreme conditions existing in these fruit regions, or for the purpose of producing fruits which shall ripen at a period to better meet the needs of the market's supply from these regions.

Cooperation.—Texas, Maryland, and Iowa experiment stations, Iowa State Horticultural Society, and private individuals.

Location.—Arlington Farm, Va., Troup, Tex., Charles City, Iowa, Storrs, Conn., and College Park, Md.

Date begun.—1913.

Results.—A large number of varieties of peaches and plums in Texas, apples, plums, and pears in Iowa, and apples in Maryland have been pollinated and many promising seedlings secured.

Assignment.—W. F. Wight, C. P. Close.

Proposed expenditures, 1916-17.—\$1,940.

Total, Fruit Improvement through Breeding, Selection, and Domestication, \$13,413, including \$1,450 statutory.

INVESTIGATIONS IN SYSTEMATIC POMOLOGY.**Fruit History and Classification:**

Object.—To classify the varieties of fruits into groups based on their genetic relationships; to accumulate data relative to the locality, manner of origin, and parentage of the varieties; to study the variation that occurs in each variety; and to prepare descriptions from original or other authentic material of varieties now in cultivation.

Fruit History and Classification—Continued.

Procedure.—Data concerning the origin of varieties are obtained by correspondence and by reference to various published sources of information. Material of each variety is secured from the original tree or from other authentic source when the original tree is no longer available, carefully studied, and a description (with necessary illustrative material) prepared representing the type for a given variety. Additional authentic material is also studied in detail to establish the variation from the type that may occur in a variety, and a classification is being prepared, based on relationships as determined either by known parentage or as shown by such characters as are found to be constant and which are known from investigation to indicate relationship.

Cooperation.—State experiment stations, and private growers in various parts of the United States.

Location.—Washington, D. C.

Date begun.—1913.

Results.—A large amount of information concerning the origin of varieties has been brought together, important characters discovered enabling varieties hitherto frequently confused to be distinguished, and many detailed descriptions prepared.

Assignment.—W. F. Wight.

Proposed expenditures, 1916-17.—\$4,560.

Fruit Nomenclature:

Object.—To secure a simple, pure, and stable nomenclature of the cultivated American fruits.

Procedure.—Data are secured through correspondence with nurserymen and commercial and amateur fruit growers, by reference to current and standard literature and by verification of varieties in trial grounds at the Arlington Farm and elsewhere throughout the United States.

Cooperation.—American Pomological Society, American Association of Nurserymen, and various State horticultural and pomological societies.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1901.

Results.—Publications have been issued as follows: B. P. I. Bulletins 56, "Nomenclature of the Apple," and 126, "Nomenclature of the Pear"; and various contributions to proceedings of societies. An increased public interest has been aroused in the purification and simplification of varietal names of fruits; a willingness has been manifested on the part of nurserymen to adopt the characterization of varieties suggested by the department; and a marked decrease in the practice of introducing old varieties under new names has resulted.

Assignment.—E. R. Lake.

Proposed expenditures, 1916-17.—\$3,520.

Fruit Identification and Variety Collections:

Object.—To identify, model, and prepare illustrations and characterizations of fruits of various kinds grown in the fruit areas of the United States, and to maintain variety collections of tree fruits and berries for specific purposes in connection with the Arlington Farm.

Procedure.—Fruit-variety collections are maintained at the Arlington Farm, and specimens of fruits from various fruit-growing sections of the country are secured for study and identification.

Cooperation.—State experiment stations, county agents, horticultural societies, nurserymen, and individual fruit growers throughout the country.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—About 1890.

Results.—The variety collections at the Arlington Farm include over 900 varieties of tree fruits, over 500 varieties of berries, and 150 grapes. Thousands of paintings, models, and descriptions of fruits have been made to aid in the work of variety identification, and several thousand identifications are made each year for the benefit of commercial and amateur fruit growers.

Assignment.—C. P. Close.

Proposed expenditures, 1916-17.—\$12,780.

Total, Investigations in Systematic Pomology, \$20,860, including \$8,160 statutory.

FRUIT-UTILIZATION INVESTIGATIONS.

Fruit Utilization:

Object.—To secure information relative to the best and most practical methods of using the lower grades of fruit and surplus stock which can not be marketed profitably in a fresh state.

Procedure.—The methods of desiccation, canning, and preserving fruits are being studied with the idea of modifying commercial practices in such a way as to adapt them to the needs of the individual fruit grower so situated as not to be able to take advantage of the markets offered by the commercial industry, in order to conserve a large and valuable product which is now largely lost because there are no simple and inexpensive methods of quickly converting it into a stable, marketable product.

Cooperation.—Bureau of Chemistry.

Location.—Washington, D. C.

Date begun.—About 1910.

Results.—Data have been accumulated which, prior to publication, are proving of value in answering inquiries from correspondents and incidentally in other ways. Farmers' Bulletins 213, 291, and 426 have been issued. Information regarding desiccation of berries other than black raspberries, as well as prunes, peaches, and figs, has been secured.

Assignment.—H. C. Gore.

Proposed expenditures, 1916-17.—\$3,250.

Total, Pomological Investigations, \$128,147, including \$23,087 statutory.

[Research.]

HORTICULTURAL INVESTIGATIONS.

SUPERVISION.

Supervision:

Object.—General administration and direction of the research projects and necessary incidental clerical work.

Cooperation.—Other offices within the department.

Location.—Washington, D. C.

Date begun.—1900.

Assignment.—L. C. Corbett, H. P. Gould.

Proposed expenditures, 1916-17.—\$8,293, including \$3,693 statutory.

VEGETABLE HANDLING AND STORAGE INVESTIGATIONS.

Vegetable Handling and Storage:

Object.—To determine the factors governing the successful handling, transportation, and storage of vegetables, and to demonstrate methods by which decay, deterioration, and loss in transportation, at market terminals, and in storage can be reduced to a minimum.

Procedure.—Studies are made of the cultural, soil, climatic, and other factors affecting the keeping quality of vegetables; of the handling methods employed in harvesting and preparing the vegetables for shipment; of the handling methods in transportation, at terminals, and in storage warehouses; as well as of the relation of transportation and warehouse facilities to keeping quality. The investigations are conducted by the handling of vegetables from regions and fields selected for the problems in view. The vegetables are harvested, packed, and shipped under the direction of bureau representatives and inspected at destination by bureau representatives. The precooling investigations are conducted in the same general manner, shipments being made of comparable series of precooled and nonprecooled vegetables in carload lots and precooling being accomplished either in commercial plants or with special equipment provided by the bureau. Temperature records in transit and the condition of vegetables at terminals are obtained by bureau representatives accompanying the shipments and by actual inspection of the vegetables at destination. In the storage work the vegetables are handled by the bureau representatives in accordance with the problems being studied. The behavior of the vegetables in storage is determined by frequent inspections in cold and common storage warehouses. The regions, fields, and warehouses are selected with the view of working out both fundamental principles and special or local problems, the vegetables being harvested and handled throughout by bureau representatives.

Vegetable Handling and Storage—Continued.

Cooperation.—Office of Markets and Rural Organization, Bureau of Chemistry, vegetable growers' associations and exchanges, individual growers, independent shippers, railway companies, refrigerator-car lines, storage warehouses, and vegetable receivers.

Location.—Field work in Georgia, Florida, Indiana, New York, New Jersey, Pennsylvania, Maine, and California, with inspections at New York, Boston, Chicago, and other vegetable-marketing centers.

Date begun.—1912.

Results.—The factors governing the successful handling and shipment of vegetables have been determined, especially for celery in Florida and New York and lettuce in Florida. Investigations are under way on tomatoes from Florida and Mississippi, melons from various producing centers, and potatoes in Maine. Data published in Farmers' Bulletins 282 and 548. A manuscript on the precooling and handling of lettuce and celery in Florida has been prepared and submitted for publication.

Assignment.—H. J. Ramsey, H. C. Thompson, William Stuart, D. N. Shoemaker, E. L. Markell, George L. Fischer, W. C. Quick.

Proposed expenditures, 1916-17.—\$3,500.

TRUCK-CROP PRODUCTION INVESTIGATIONS.**Truck-Crop Production:**

Object.—To investigate the truck-crop and market-gardening possibilities of various sections of the United States, and to ascertain the factors limiting crop production or responsible for crop deterioration; to study the best methods of cultivating, propagating, fertilizing, harvesting, packing, and storing vegetable crops; for sweet potatoes, to determine the best cultural practices, including propagation of plants, planting, fertilization, harvesting, and storing, as well as varietal adaptability; for onions, the best growing and storage methods, as well as the possibility of producing Denia onions and growing Denia onion seed; for asparagus, the fertilizers and method of cultivation for best results; for celery, the methods of handling to overcome losses in the field and in storage.

Procedure.—Surveys of truck-growing and market-gardening districts in which the above-enumerated crops demand attention because of deterioration or losses are made to determine the factor or factors in the cultural or handling operations which are responsible for the loss or deterioration. As soon as these factors are determined, tests are planned and inaugurated for the purpose of developing practical means of overcoming these difficulties or losses. Each crop district is carefully surveyed, the limiting factors noted so far as they can be determined, and plans inaugurated to test the effectiveness of known methods of overcoming such handicaps.

Cooperation.—State experiment stations of Delaware, North Carolina, and South Carolina, the Virginia Truck Experiment Station at Norfolk, Va., and practical growers, shippers, and storage warehousemen.

Location.—Indiana, Illinois, Maryland, New Jersey, Delaware, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Texas, New York, Ohio, New Mexico, Arizona, California, Michigan, Florida, and Washington, D. C.

Date begun.—1900.

Results.—Sweet potato investigations: Satisfactory methods of storage have been devised and extended to all sections of the South. Records kept on 15,200 bushels of sweet potatoes stored in 14 houses in various sections for an average storage period of 125 days show a loss by decay of 3.16 per cent and shrinkage of 9.45 per cent. The minimum decay was 0.73 per cent and the minimum shrinkage 8 per cent, while the maximum decay was 22.14 per cent and the maximum shrinkage 13.57 per cent. The variety collection of sweet potatoes has been kept up and seven new varieties added. All of these have been grouped and classified. A number of foreign varieties have been tested. Data are published in Farmers' Bulletins 324 and 548 and a special circular from the Office of the Secretary. Material is on hand for technical bulletins on sweet-potato storage, the construction of storage houses, and the classification and descriptions of varieties.

Onion investigations: Denia onions produced in this country are equal to the imported product. The average yield of Denia onion bulbs is 30,000 to 40,000 pounds per acre, and as high as 60,000 pounds have been produced. Seed

Truck-Crop Production—Continued.

produced at the present time on a commercial scale is equal to the imported seed. Data have been published on onion culture in Farmers' Bulletins 354 and 434, and additional data are on hand for a bulletin on Denia onions.

Celery investigations: Data on the culture of celery are contained in Farmers' Bulletin 282, and the results of experimental work on celery storage will be incorporated in a technical bulletin to be issued later. Experimental work shows the value of a small crate for storing celery. Celery keeps 30 to 40 per cent better in the crates designed in connection with the department's investigations than in the crates commonly used, when the crop is stored for three months or longer. The difference in the keeping quality of celery at different heights in the storage room has been worked out and shown to be correlated with difference in temperature. Data on other fundamental storage problems have been secured.

Assignment.—H. C. Thompson, Fred E. Miller.

Proposed expenditures, 1916-17.—\$5,835.

(Adaptability of Vegetables to Environment: Discontinued as a separate project; included under "Truck-Crop Production.")

Truck-Crop Fertilizers:

Object.—To determine the injurious effects, if any, of continuous heavy applications of inorganic salts to lands perpetually cropped in hoe crops; to determine the rotations which can be used in truck-crop practice which will maintain the productive capacity of the soil.

Procedure.—An elaborate experiment has been under way since 1908. In this work nearly all kinds of fertilizers have been used in varying amounts and combinations, with several kinds of vegetables in rotation. In addition to commercial fertilizers, manure, crimson clover, and lime are used, each alone and in combination with fertilizers. Accurate records are kept of the yields of all plats.

Cooperation.—Virginia Truck Experiment Station.

Location.—Norfolk, Va.

Date begun.—About 1908.

Results.—The experiments have shown the necessity of adding humus in some form in order to produce a profitable crop of vegetables and that phosphorus is the limiting fertilizing element. As continuous heavy applications of commercial fertilizers without humus have resulted in some cases in creating an environment in which plants do not thrive, it is evident that such applications have an injurious effect on vegetation. In addition to the results published in Bulletin 9 of the Virginia Truck Experiment Station, "Fertilizer Experiments with Kale," there are available data for other publications.

Assignment.—H. C. Thompson, T. C. Johnson.

Proposed expenditures, 1916-17.—\$300.

Peanuts:

Object.—To improve commercial varieties of peanuts; to determine the best cultural methods, including the use of fertilizers, crop rotations, and methods of harvesting, thrashing, etc.; to extend the use of the peanut as human food; and to demonstrate the value of the peanut as a forage crop, especially in connection with pork production in the Southern States.

Procedure.—Field studies are made to secure data on the methods of cultivation, fertilization, rotation, harvesting, and thrashing. In the work of improving varieties selections are made of high-yielding hills, and these are planted in experimental breeding plats and subsequent selections made.

Cooperation.—Virginia and South Carolina experiment stations, farmers, oil mills, cleaners, handlers, and peanut-butter manufacturers.

Location.—Virginia, North Carolina, South Carolina, Alabama, Mississippi, Louisiana, Texas, and Oklahoma.

Date begun.—1905.

Results.—Data are contained in Farmers' Bulletin 431, B. P. I. Circulars 88 and 98, and a special circular from the Office of the Secretary; and a manuscript on peanut oil is in the hands of the printer. The peanut industry has been greatly extended throughout the South, especially in the regions where the boll weevil is present. Selection work shows great variation in the yield of individual plants and the possibility of improving commercial varieties.

Assignment.—H. C. Thompson, F. E. Miller.

Proposed expenditures, 1916-17.—\$3,450.

Adaptation of Truck Crops to Organic Soils (Mucks and Peats):

Object.—To determine truck crops adapted to organic soils; to study methods of treatment of different types of soils and their use in growing greenhouse crops.

Procedure.—Representative tracts of organic soils are selected for experimental work, both in the field and under glass. In the field work fertilizer and cultural investigations are carried on with the important organic-soil vegetables. In the greenhouse various mixtures of organic soils, sand, and clay are used in growing the common greenhouse vegetables and flowers. In addition to the experimental features of this work, field studies are made and data secured on the crops grown and methods of culture practiced in the various sections of the country.

Cooperation.—American Peat Society, Bureau of Mines, Indiana Experiment Station, and practical truck growers.

Location.—Washington, D. C., New Jersey, Indiana, Ohio, and Michigan.

Date begun.—1912.

Results.—Data secured on fertilizers for truck crops in New Jersey and Indiana show that potash is usually the limiting element of plant food, although a small application of phosphorus in connection with potash increases the yield. Manure produced very large crops in Indiana when used alone and in combination with fertilizers other than potash, but in New Jersey the manure was of little value. Lime has been of little value in either the New Jersey or Indiana experiments. Greenhouse experiments show the value of a good type of organic soil for forcing greenhouse crops. These experiments also show that a chemical analysis of organic soils is of little value in determining their value for crop production.

Assignment.—H. C. Thompson, F. E. Miller.

Proposed expenditures, 1916-17.—\$6,185.

Production of Vegetable and Flower Seeds:

Object.—To determine the most economical and successful methods of growing vegetable and flower seeds.

Procedure.—Field tests are conducted and the methods commonly used by seed growers in different parts of the country studied.

Cooperation.—Seed growers throughout the United States.

Location.—Washington, D. C., Arlington Farm, Va., and the farms of seed growers with whom arrangements may be made from time to time.

Date begun.—1907.

Results.—Preliminary data for publications on the growing of different kinds of vegetable and flower seeds in the United States are being accumulated. Publication issued: B. P. I. Bulletin 184, "Production of Vegetable Seeds: Sweet Corn and Garden Peas and Beans."

Assignment.—W. W. Tracy, sr., D. N. Shoemaker.

Proposed expenditures, 1916-17.—\$250.

Total, Truck-Crop Production Investigations, \$16,020, including \$2,340 statutory.

TRUCK-CROP IMPROVEMENT THROUGH BREEDING, SELECTION, AND DOMESTICATION.**Standardization of Varieties of Vegetables through Selection:**

Object.—To standardize the different varieties of vegetables with a view to secure uniformity in size, season, productiveness, etc.

Procedure.—Seeds of the best strains of different varieties are planted, selections which conform most closely to the desired type made, seeds grown from these, and the selection continued until the desired uniformity of type is obtained.

Location.—Washington, D. C., and Arlington Farm, Va..

Date begun.—1903.

Results.—Certain varieties of cauliflower and lettuce have been developed to a very high degree of uniformity, and similar progress has been made with field beans, tomatoes, and garden peas.

Assignment.—W. W. Tracy, sr., D. N. Shoemaker.

Proposed expenditures, 1916-17.—\$4,989.

Improvement of Vegetables through Hybridization and Domestication:

Object.—To develop better strains and varieties of vegetables through the usual processes of crossing and hybridization.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1915.

Improvement of Vegetables through Hybridization and Domestication—Con.

Results.—Very material gains in productiveness have been proven for the first-generation cross between selected varieties of tomatoes.

Assignment.—D. N. Shoemaker.

Proposed expenditures, 1916-17.—\$655.

Total, Truck-Crop Improvement through Breeding, Selection, and Domestication, \$5,644, including \$1,664 statutory.

IRISH-POTATO INVESTIGATIONS.**Irish Potatoes:**

Object.—To determine the influence of soil and climate on the quality and productiveness of potatoes; investigate conditions necessary for the production of tubers of special merit for baking and boiling purposes; select and develop strains of potatoes particularly suitable to special soil and climatic conditions and for the purpose of increasing the yield per acre by eliminating unproductive hills; ascertain the best source of seed potatoes; study the influence of storage conditions on vitality, rate of germination, and crop yields; study cultural practices to improve potato culture; produce new varieties of better quality, greater disease resistance, and greater productiveness; import foreign wild and cultivated sorts to improve cultivated varieties; conduct nutrition investigations to determine the food requirements of the potato plant; conduct investigations to determine conditions which influence tuber development; maintain a variety collection to improve existing strains by hill selections and tuber-unit methods; determine the relative value of different methods of treating, handling, and cutting seed potatoes; and study the nomenclature and varietal relationships of our present commercial varieties of potatoes.

Procedure.—Field experiments are conducted at stations maintained at Presque Isle, Me., Norfolk, Va., Swannanoa, N. C., Greeley, Colo., Jerome, Idaho, and Arlington Farm, Va. In the irrigation investigations at Greeley, Colo., and Jerome, Idaho, the rate and date of application of water to the growing crop will be determined, for the purpose of ascertaining its effect upon the resultant health and productiveness of the plants. A test at Greeley, Colo., has in view the determination of the relative value of certified seed potatoes. A study of the relative vigor and productiveness of plants produced from mature and immature seed is under way; also experiments with potatoes to determine their relative value for culinary purposes.

Cooperation.—Maine Experiment Station, Virginia Truck Experiment Station, Colorado Experiment Station, and the Greeley (Colo.) Commercial Club; also nominal cooperative relationship with the Idaho Experiment Station and the North Carolina Experiment Station. The following stations are cooperating in testing promising seedling potatoes: Kansas, Nebraska, Iowa, Minnesota, Michigan, New York, Massachusetts, Rhode Island, and Vermont.

Location.—Arlington Farm and Norfolk, Va., Presque Isle, Me., Jerome, Idaho, Middle River, Cal., Swannanoa, N. C., Greeley, Colo., Mitchell, Nebr., and points in Minnesota.

Date begun.—1902.

Results.—About 75,000 seedlings have been grown to date, of which approximately 74,000 have been discarded as unfit for further test, and approximately 1,000 are now under observation. Data in Farmers' Bulletins 407 and 533, B. P. I. Circular 113, Department Bulletin 176, "Group Classification and Varietal Descriptions of Some American Potatoes," and Department Bulletin 195, "Potato Breeding and Selection." A farmers' bulletin entitled "Potato Storage and Storage Houses" is now in press.

Assignment.—William Stuart, W. V. Shear, C. F. Clark, G. W. Dewey, P. M. Lombard.

Proposed expenditures, 1916-17.—\$24,427, including \$2,400 statutory.

INVESTIGATIONS IN SYSTEMATIC OLERICULTURE.**Vegetable History and Nomenclature:**

Object.—To accumulate data relating to the history of varieties of vegetables, with special reference to old and little-known varieties; to assemble information relating to the origin of varieties, and to secure a simple and stable nomenclature for the cultivated vegetables.

Procedure.—This work is conducted through correspondence and discussion with interested parties, through the accumulation of data by reference to

Vegetable History and Nomenclature—Continued.

current and standard literature, and by verification of varieties on trial grounds at the Arlington Farm and elsewhere throughout the United States.

Cooperation.—Vegetable Growers' Association of America, American Seed Trade Association, horticultural societies throughout the United States, State libraries, and individual growers.

Location.—Washington, D. C., and various points throughout the United States.

Date begun.—1903.

Results.—Effective cooperation has been secured between the organized vegetable growers and the organized seedsmen of the country with the view of reforming undesirable practices in naming and describing strains and varieties of vegetables. Unpublished data in regard to the origin and history of varieties of vegetables are being collected from various sources, including the originators of valuable strains. Publications: B. P. I. Bulletins—6, "List of American Varieties of Peppers"; 21, "List of American Varieties of Vegetables"; 69, "American Varieties of Lettuce"; and 109, "American Varieties of Garden Beans."

Assignment.—W. W. Tracy, sr., D. N. Shoemaker.

Proposed expenditures, 1916-17.—\$1,570, including \$1,320 statutory.

VEGETABLE-UTILIZATION INVESTIGATIONS.**Vegetable Utilization:**

Object.—To secure information relative to the best and most practical methods of using the lower grades of vegetables and surplus stock which can not be marketed profitably in a fresh state.

Procedure.—The methods of desiccating, canning, and preserving vegetables are being studied with the idea of modifying commercial practices in such a way as to adapt them to the needs of the individual vegetable grower so situated as not to be able to take advantage of the markets offered by the commercial industry, in order to conserve a large and valuable product which is now largely lost because of the lack of simple and inexpensive methods of quickly converting it into a stable marketable product.

Cooperation.—Bureau of Chemistry.

Location.—Washington, D. C.

Date begun.—About 1905.

Results.—Many data accumulated in regard to the canning of tomatoes, preparation of pickles, and desiccation of vegetables.

Assignment.—H. C. Gore.

Proposed expenditures, 1916-17.—\$2,000.

LANDSCAPE-GARDENING AND FLORICULTURE INVESTIGATIONS.**Landscape Gardening:**

Object.—To study the adaptability and uses of trees, shrubs, and other plants for ornamental planting about schools and farmsteads, on streets and roadsides, and in parks and other places; to prepare planting plans; to study the regional adaptability of varieties and their relation to environment; and to study the adaptability of native wild species and such other features of landscape gardening as may from time to time call for attention.

Procedure.—The study of adaptability is conducted by observing the plants used for various purposes and the effects obtained. Planting plans are prepared for Government grounds when requested, also for a limited number of schools in each State, provided they are teaching agriculture, and occasionally for a farmstead where there is assurance of its being carried out and the value for purposes of demonstration seems to warrant. The regional adaptabilities of varieties are studied from published lists of plants thriving in specific localities, by the recorded observation of testing of plants at various selected stations, and in cooperation with national-forest rangers.

Cooperation.—Voluntary individual observers, experiment station horticulturists, park superintendents, and Forest Service nurseries and experiment stations.

Location.—Washington, D. C., Arlington Farm and Norfolk, Va., Augusta and Atlanta, Ga., Ithaca, N. Y., Camden and Cleveland, Ohio, and Lake Forest, Ill.

Date begun.—1901.

Results.—A farmers' bulletin entitled "Roses for the Home" has been submitted for publication, one on street trees is partially prepared, and material is available for another on roadside trees and one on lawn maintenance. Generalization

Landscape Gardening—Continued.

from a large amount of data obtained may also be made about beautifying the farmstead, and on hedges, seaside plants for use in certain restricted areas, pruning of ornamental plants, and the growing of herbaceous perennials. Studies are under way on out-of-door roses, hardy chrysanthemums, the iris, and ornamental plants suitable for growing in certain localities where the range of ornamental plants known to succeed is limited.

Assignment.—F. L. Mulford.

Proposed expenditures, 1916-17.—\$5,903.

Floriculture:

Object.—To determine the factors controlling the propagation, growing, handling, and disposal of tender plants, cut flowers, and other plants suitable for florists' use, whether under glass or outdoors; also to determine the principles underlying the production of new varieties for this purpose, the improvement of varieties, and the domestication and introduction of wild plants of value for floricultural purposes.

Procedure.—Studies are made by visiting florists' establishments and dealers, as well as by growing the plants. Crosses are made of promising species and varieties, the seedlings are grown, and selections made from them. Records are made of new introductions, their history, and character.

Cooperation.—Florists, floricultural societies, and individuals.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1904.

Results.—New varieties of dahlias and chrysanthemums have been produced, and progress with similar work on carnations has been made.

Assignment.—F. L. Mulford, E. M. Byrnes.

Proposed expenditures, 1916-17.—\$1,100.

Bulb Growing:

Object.—To study the possibilities of growing bulbs of various kinds in the United States, including their propagation, handling, curing, and testing, and to render assistance in developing a bulb-growing industry.

Procedure.—Bulbs of various kinds are grown either on a commercial scale or in an experimental way and tested as to their value as compared with bulbs grown at other points.

Location.—Washington, D. C., and Bellingham, Wash.

Date begun.—1902.

Results.—Bermuda lilies have been grown successfully from seed. Bulbs of narcissi, tulips, and hyacinths have been grown at Bellingham, Wash., that compare favorably with bulbs grown elsewhere. Department Bulletin 28, "Experiments in Bulb Growing at the United States Bulb Garden at Bellingham," and B. P. I. Bulletin 39, "The Propagation of the Easter Lily from Seed," have been issued.

Assignment.—David Griffiths, P. H. Dorsett, Peter Bisset.

Proposed expenditures, 1916-17.—\$10,300. This total includes \$6,500 from appropriation for the purchase and distribution of valuable seeds.

Ornamental Nursery:

Object.—To determine the most efficient and economical methods of propagating ornamental plants; to study the congeniality between various ornamental plants and those plants used for stocks for same, as well as the adaptability of different stocks to different climatic and soil conditions.

Procedure.—Cuttings from blind and flowering wood are used to determine the relative value of such stocks for propagating roses. The value of cuttings from floriferous plants as compared with the ordinary greenhouse run of stock is being tested. The requirements of seeds of different kinds, as well as the adaptation of different ornamental plants to propagation by stratification, layers, cuttings, budding, and grafting, are considered in connection with the different species investigated.

Cooperation.—Nurserymen and private individuals throughout the United States.

Location.—Washington, D. C., Arlington Farm, Va., and nurseries with which cooperation may be arranged from time to time.

Date begun.—1915.

Results.—The work has been organized, but it is yet too early to report definite results.

Assignment.—F. L. Mulford.

Proposed expenditures, 1916-17.—\$1,576.

Greenhouse Problems:

Object.—To study the methods of greenhouse, hotbed, and cold-frame construction best adapted for various purposes, together with the cost of maintaining various types of forcing structures, as well as methods of heating, ventilating, glazing, bench construction, and other details; to study soil and moisture conditions and the relation of all factors to the successful growth of ornamental and florists' plants, vegetables, and fruits.

Procedure.—The subject is studied through investigations of the methods and practice of commercial establishments and through definite experiments at the Arlington Farm on special phases of the problems as they can be taken up.

Cooperation.—Office of Farm Management and individual growers.

Location.—Field work in most of the States east of the Rocky Mountains.

Date begun.—1914.

Results.—About 3,000 greenhouse plants have been studied and many records obtained. Manuscripts for two bulletins are under way.

Assignment.—L. C. Corbett.

Proposed expenditures, 1916-17.—Cost of work carried under funds of the Office of Farm Management in connection with the project "Farm Equipment."

Total, Landscape-Gardening and Floriculture Investigations, \$18,879, including \$6,336 statutory.

Total, Horticultural Investigations, \$80,333, including \$17,753 statutory.

[Research.]

ARLINGTON FARM.**Arlington Farm:**

Object.—To maintain a field laboratory for the various bureaus and offices of the Department of Agriculture.

Cooperation.—Various bureaus and offices of the department.

Location.—Arlington estate, Rosslyn, Va.

Date begun.—1900.

Results.—In general, the land is being gradually improved and drainage systems extended. Additional areas have been rendered suitable and assigned to experimental work. An effort has been made to improve the farm facilities to accommodate the investigations now in progress and to render as much assistance as possible not only to this work but to any new projects that may be inaugurated.

Assignment.—L. C. Corbett, E. C. Butterfield, J. H. Criswell.

Proposed expenditures, 1916-17.—\$29,880, including \$14,880 statutory.

[Research.]

EXPERIMENTAL GARDENS AND GROUNDS.**General Care of Greenhouses and Grounds:**

Object.—To maintain a range of 31 greenhouses for general plant-breeding, pathological, and entomological work of the department, including seed-testing, experimental work with citrus and other subtropical fruits, vegetables, florists' crops (including roses, carnations, and chrysanthemums), etc.; to propagate plants for ornamenting the grounds of the department and those of the Weather Bureau, and for congressional distribution; and to maintain the department grounds in good condition.

Location.—Washington, D. C.

Date begun.—1862.

Assignment.—Edward M. Byrnes.

Proposed expenditures, 1916-17.—\$54,590, including \$42,900 statutory.

[Research.]

FOREIGN SEED AND PLANT INTRODUCTION.**GENERAL DIRECTION OF PLANT INTRODUCTIONS.****Administration:**

Object.—The supervision of the scientific and clerical force necessary to maintain an extensive exchange of experimental seeds and plants between the experts of foreign countries and the plant experts of America, with the view to providing every plant experimenter in this country who wishes to test new foreign crop plants with material for his experiments.

Administration—Continued.

Procedure.—Through extensive correspondence and special shipping arrangements with foreign institutions and individuals and our diplomatic and consular officials abroad, on the one hand, and Federal and State experiment station officials, private experimenters, and park superintendents, on the other, this international exchange is kept up and the growing demand supplied for new and rare seeds and plants for the development of new industries in this country. From time to time the results obtained from these experiments are ascertained and published.

Cooperation.—Federal officials, State departments of agriculture, State experiment stations, botanic gardens, agricultural colleges and schools of horticulture, city park superintendents, and private experimenters.

Location.—Washington, D. C.

Date begun.—Section of Seed and Plant Introduction established in 1898; project started 1907.

Results.—Over 43,000 foreign varieties of seeds and plants have been introduced and distributed, and many of these have resulted in industries, the money-earning value of which amounts to many millions each year. The durum wheats, Swedish barleys, Russian oats, special dry-land, cold-region, and irrigated-land alfalfas, avocados, dates, Sudan and Rhodes grasses, sorghums, and seedless grapes represent some of the introductions of positive commercial importance which had their beginnings in this project but now form independent projects in other offices of the bureau.

Assignment.—David Fairchild.

Proposed expenditures, 1916-17.—\$19,610.

Plant Inventory and Records:

Object.—To maintain such a record of every foreign seed and plant introduction from the time it is found in a foreign country until the time it becomes a commercial success in America that a connected history of its introduction can be written.

Procedure.—All importations are opened and inspected by pathological and entomological inspectors of the Federal Horticultural Board. These various introductions are given distinctive numbers, and all information available referring to the introduction is recorded on a card bearing this number and filed. An inventory is published quarterly containing all the introductions received during that period. A bulletin of foreign plant introductions is sent out monthly to cooperators, listing the special introductions received. Lists of applications for newly introduced material, of domestic experimenters and foreign correspondents, and a record of all material distributed are kept. An extensive collection of seeds and specimens is maintained so that any new plant can be identified botanically.

Cooperation.—Department officials, State experiment stations, and private experimenters.

Location.—Washington, D. C.

Date begun.—1898, when Section of Seed and Plant Introduction was established; project started 1908.

Results.—The original field notes describing over 43,000 foreign plant introductions have been printed. These accounts constitute a most valuable contribution to the history of cultivated plants. The location in this country of practically every packet of seed or every plant sent out by this office to experimenters since 1898 is recorded on cards, so that at any time it is possible to determine what distribution was given to a new plant introduction in this country. Over 2,000 introductions were made last year, and 140,465 plants and over 13,000 packets of experimental seeds were placed with experimenters and a record kept of each.

Assignment.—David Fairchild, S. C. Stuntz, H. C. Skeels.

Proposed expenditures, 1916-17.—\$13,650.

Placing New Plant Introductions:

Object.—To place the newly introduced plants in the hands of the bona fide plant experimenters of the country where they will be properly taken care of, tested, and reported upon.

Procedure.—Through correspondence and by means of special agreements with the plant breeders, horticulturists, and agriculturists of the State experiment stations, superintendents of city parks and arboreta, and the large number of private plant experimenters and breeders of the country, the new plants are ordered out at the proper season for the different localities and to the experi-

Placing New Plant Introductions—Continued.

menters best able to give them a fair test. All the clerical machinery of a well-equipped nursery is employed to accomplish this object, and special inspection trips to various portions of the country are made to keep in touch with the behavior of the material sent out and the widely different climatic conditions and plant requirements of the various sections of the country.

Location.—Washington, D. C.

Date begun.—1916, as a separate project; practically in operation since the office was established in 1898.

Results.—As a result of the operation of this project there are growing in various sections of the country thousands of new and promising fruit and ornamental trees and shrubs, forage crops, timber trees, vegetables, windbreak plants, shelter-belt plants, avenue trees, cover crops, and oil-producing trees, which are being tested and reported upon. Many have already become established and proven their adaptability to the climate of the United States. Over 140,465 plants and 13,000 packets of seed were placed in the spring of 1916.

Assignment.—David Fairchild, Peter Bisset.

Proposed expenditures, 1916-17.—\$7,600.

Protection and Propagation of New Plant Introductions:

Object.—To provide facilities for the adequate inspection by the officials of the Federal Horticultural Board of all newly introduced plants; to develop and apply improved methods of reproducing plants by seeds and vegetative parts in such manner that they will be free from parasitic enemies and transmissible diseases; to discover and apply improved methods for the rapid propagation, distribution, and utilization of all foreign seed and plant introductions; to work out new and improved methods of seed, seedlings, and clonal sterilization against fungi and bacteria; and to conduct field tests and trials for the purpose of determining the healthfulness of new or promising plant immigrants and their suitability for general distribution.

Procedure.—The facilities now at hand on the department grounds and those at Yarrow, Md., Chico, Cal., and Miami and Brooksville, Fla., will be utilized. In addition, special new facilities and devices will need to be developed for handling the work of producing healthy races of plants, including the provision of sterilizing and other special facilities for water and for all equipment and materials used. Eventually facilities will need to be provided for applying modern knowledge of the influence of chemical excitants, together with cold and heat, on seed and bud activity. Etherization, the use of hot water, and prolonged cold may all be made to play a part in the propagating work. The rest period of plants will play an important part in all this work, and the relation of the rest period to ease of propagation, hardiness, etc., should have consideration. All the work may be materially advanced by the discovery and use of quick-responding stocks. A complete system of records will need to be established at the start, the records to be of such a nature that each clonal and seed race may be traced to the original seed or clon. Laboratory facilities need not be elaborate. Etherization chambers and facilities for the reproduction and growth of plants in germ-free media may be evolved as the work progresses. Much of the basic work must be done under glass, where all the conditions are under measurable control, but it will be necessary to carry the work into the field, so that field tests will need to be provided for at Yarrow, Arlington Farm, Chico, Miami, and other places. Clean races of plants once secured, rapid propagation may be carried on in the usual ways at any or all of the outside stations.

Cooperation.—Federal Horticultural Board; also Laboratory of Plant Pathology and Office of Physiological and Fermentation Investigations within the Bureau of Plant Industry.

Location.—Washington, D. C., and plant-introduction field stations.

Date begun.—July 1, 1916.

Assignment.—David Fairchild, B. T. Galloway.

Proposed expenditures, 1916-17.—\$5,700.

Plant-Introduction Surveys:

Object.—To bring together in a comprehensive way for practical use all available information upon soil, climate, labor and horsepower, use of machinery, transportation facilities, markets (present and prospective), and regional and community sentiment, with the object of applying the same in the organization and successful maintenance of new crop industries through the introduction of foreign seeds and plants.

Plant-Introduction Surveys—Continued.

Procedure.—This project will involve a study of all the machinery of the office and the field at large with a view to aid in the general advancement of the work. Plant-introduction reconnaissance inventories will be organized in order to bring together the fundamental and guiding facts which will enable the office to map and chart the regions where new foreign staple and other crops may in the light of all the factors involved be successfully introduced. In this work consideration must be given not only to the factors which the individual can control but also to the factors beyond his control. A feature of the work would be the development of ways and means for arousing and centering public interest in promising new plant products.

Cooperation.—Office of Farm Management, Bureau of Crop Estimates, and Weather Bureau, in addition to the various specialists in the Bureau of Plant Industry engaged in domestic crop studies.

Location.—Washington, D. C., Yarrow, Md., Chico, Cal., Bellingham, Wash., Brooksville and Miami, Fla., and other points where foreign seed and plant introduction is under way or contemplated.

Date begun.—July 1, 1916.

Assignment.—David Fairchild, B. T. Galloway.

Proposed expenditures, 1916-17.—Cost included under project "Protection and Propagation of New Plant Introductions."

FOREIGN EXPLORATIONS.**Major Foreign Explorations:**

Object.—To explore the plant industries of foreign countries with a view to secure new varieties of plants and data which will aid in their establishment in America, as well as to discover the wild relatives of cultivated plants useful for breeding with them.

Procedure.—This includes the work of expeditions and special explorers completed within one fiscal year. American consular officials and members of foreign agricultural institutions are sent on shore expeditions for seeds and plants. These expeditions are sent out under authorized arrangements made during the year to meet unusual opportunities that arise.

Cooperation.—Various bureaus and offices of the department, foreign agricultural institutions, and United States consular officials abroad.

Location.—Washington, D. C.

Date begun.—1913 as a separate project; virtually in operation, however, since 1897.

Results.—Short exploring trips have been made by many experts of this and other offices of the bureau to investigate definite problems of foreign agriculture and secure the seeds and plants needed to solve such problems. These trips include those made by Carleton to get the durum wheats and other cereals of Russia and Siberia; by Hansen after hardy Siberian alfalfas; by Swingle, Kearney, Scofield, Bessey, Mason, and Fairchild to secure the date palms of Egypt, Algeria, Tunis, Sudan, Arabia, and Persia; by Cook and Collins to obtain Guatemalan and West Indian avocados; by Rolfs after Mexican vanilla; by Fairchild after European barleys and hops; by Cook after Palestine wheats; by Swingle, Kearney, and Fairchild to secure the Grecian and Sicilian pistache nut; by Knapp after Japanese short-kerneled rices; by Scofield to get the Tangier pea and other cover crops of Algeria; by Onderdonk after Mexican peaches; by Tull to obtain Japanese matting rushes; by Bolley after European varieties of flax; by Jones after potato varieties in Europe; by Piper to obtain the British Indian forage grasses; and by Shamel, Popenoe, and Dorsett after Brazilian oranges and tropical fruits. During the past year the war has made it seem inadvisable to send out experts because of the difficulties of shipping in their perishable plant collections.

Assignment.—David Fairchild, Wilson Popenoe.

Proposed expenditures, 1916-17.—\$5,800.

Minor Foreign Explorations:

Object.—To explore little-known regions of the world by means of foreign correspondents and to maintain and extend such international exchange of living seeds and plants as can be done through correspondence, in order to make available to plant breeders and experimenters all over the world the materials with which new and valuable plant varieties can be produced and new plant industries created.

Minor Foreign Explorations—Continued.

Procedure.—Through extensive correspondence with a widening circle of the best plant experimenters of the world who are domesticating wild plants and originating new varieties carried on through the State Department and the diplomatic and consular officials abroad, through American and other missionaries and travelers in close touch with the native races among whom they are living, and through foreign botanic gardens and agricultural institutions, an extensive exchange is carried on and thousands of new plants introduced into this country every year.

Cooperation.—Special collaborators, the American diplomatic and consular service, American missionaries, and foreign agricultural and botanical institutions.

Location.—Washington, D. C.

Date begun.—1907 as a separate project; virtually since beginning of office in 1897.

Results.—Very many important introductions have been secured by this procedure through correspondence. For example, new seedless and shipping varieties of table grapes have been introduced, as well as new cover crops for citrus orchards, new winter Cassaba melons, the calabash pipe-gourd, Australian Rhodes grass, Carib grass for Florida, the remarkably successful Sudan grass, the Feterita sorghum, collections of East Indian mangos, the Queensland nut, the chickpea or Garbanzos, the horse bean, South Chinese peaches, Japanese flowering cherries and new stocks for the cultivated cherry, and large collections of soy beans, rice, wheats, barleys, cowpeas, oriental persimmons, velvet beans, bananas, cork oaks, asparagus, tobacco, potatoes, and corn.

Assignment.—David Fairchild, S. C. Stuntz.

Proposed expenditures, 1916-17.—\$5,600.

South China Explorations:

Object.—The exploration of the provinces of China lying southeast of Shanghai and south of the Yangtse River, which are practically unknown from the standpoint of American agriculture, for the purpose of securing collections of southern peaches, the edible and timber bamboos, the tung or wood-oil tree, and improved varieties of tallow trees; the litchi, a promising new southern fruit; the longan, an edible nut-producing oak; root crops for wet lands, varieties of rice, soy beans, remarkable southern raspberries, blackberries, and pears, rare and promising ornamental shrubs and timber trees, and new varieties and species of chestnuts.

Procedure.—The experienced agricultural explorer, Frank N. Meyer, who has spent six years in northern China and Manchuria and is familiar with the methods of exploration in that country, will travel mostly on foot through the region, searching for new varieties of our cultivated plants and their wild relatives and studying the systems of agriculture employed there, and will write reports on such practices, and prepare descriptions, with photographs, of such varieties and species of plants which he finds there and sends in, as in his opinion may be valuable for introduction into this country.

Cooperation.—Through the State Department with our diplomatic and consular officials in China, with Chinese governmental officials, and American and other missionaries in the regions visited.

Location.—South China and, en route, Japan and possibly British India.

Probable date of completion.—1919. It has been found by experience that an exploration of regions such as the interior of China can best be made on a three-year basis.

Assignment.—David Fairchild, Frank N. Meyer.

Proposed expenditures, 1916-17.—\$6,000.

Total, Foreign Explorations, \$17,400, including \$2,200 statutory.

PLANT-INTRODUCTION FIELD INVESTIGATIONS.**Chico Plant-Introduction Field Station:**

Object.—To grow such of the newly introduced seeds, cuttings, plants, scions, etc., as can best be propagated and tested in the climate of the locality where the station is situated, and to keep all necessary records of their behavior; to discover and eradicate any insect or fungous diseases among them, so that large numbers of small healthy plants produced from these new introductions will be available for intelligent distribution to experimenters.

Chico Plant-Introduction Field Station—Continued.

Procedure.—Incoming seeds, plants, and plant material are sent to this station and recorded. This material is planted out, tested preliminarily, and propagated. It is then distributed into the sections of the country deemed suitable to its growth for further testing.

Location.—Chico, Cal.

Date begun.—1904.

Results.—During the past year 102,711 new plants were propagated and 48,176 distributed, exclusive of figs, pistache, grapes, etc., grown for other offices of this bureau. These included such important introductions as the jujube, Chinese dry-land peach stocks, Japanese stocks for cherries, a Chinese chestnut more or less resistant to the chestnut blight, new hybrid chestnuts, new hard-shelled almonds, the Fei peach, tung or wood-oil trees, early ripening olives, the carob fodder tree, a dwarf lemon, North Chinese walnuts, Chinese elms, and various new dooryard shrubs.

Assignment.—David Fairchild, P. H. Dorsett, Peter Bisset, R. L. Beagles.

Proposed expenditures, 1916-17.—\$11,820.

Miami Plant-Introduction Field Station:

Object.—Same as Chico station.

Procedure.—Same as Chico station.

Location.—Miami, Fla.

Date begun.—1907.

Results.—The important varieties of the East Indian mango, now grown throughout subtropical Florida, the best varieties of annonas, the remarkable fragrant-flowered edible-fruited hedge plant carissa, the Mexican leguminous shade tree Pithecolobium, small-fruited papayas, the West Indian akee, the Rhodes grass, the yam bean, the cajaput tree for swampy lands, the important winter-fruited avocados, and many others have come into general use through the activities centered in this station and have aided in building up a new type of agriculture suited to southern Florida and southern California. The development of the new 25-acre permanent garden is well under way, avocado, mango, annona, and other tropical fruit areas having already been planted on it. Owing to the citrus-canker quarantine only limited distributions were permitted from the station last year. These distributions comprised 344 mango and 2,570 avocado plants sent to experimenters in Dade and Broward Counties.

Assignment.—David Fairchild, P. H. Dorsett, Peter Bisset, Edward Simmonds.

Proposed expenditures, 1916-17.—\$6,320.

Brooksville Plant-Introduction Field Station:

Object.—Same as Chico station.

Procedure.—Same as Chico station.

Location.—Brooksville, Fla.

Date begun.—1909.

Results.—The plantation of Japanese timber bamboo has reached a stage at this station where its possibilities can be better seen and uses for it are beginning to be appreciated. Preparations have been completed now for the rapid propagation of this species. The crop of dasheens this year amounted to 500 bushels, and these supplied some of the best material for distribution to consumers. A considerable planting of the new vegetable chayote yielded enough fruits to inaugurate experiments in its exploitation in the North, where it met with general approval.

Assignment.—David Fairchild, P. H. Dorsett, Peter Bisset, J. E. Morrow.

Proposed expenditures, 1916-17.—\$5,000.

Rockville Plant-Introduction Field Station:

Object.—Same as Chico station.

Procedure.—Same as Chico station.

Location.—Near Rockville, Md.

Date begun.—1910.

Results.—During the past year 127,326 new plants were propagated for distribution. These included tung or wood-oil trees, seedlings of Japanese flowering cherries for stocks, *Prunus tomentosa* for the Northern States, Japanese bamboos, seedling hybrid grapes for the Office of Pomology, windbreak plants, dry-land Chinese poplars for cold Northern States, Chinese chestnuts more or less resistant to the chestnut blight, a Chinese elm especially adapted to the drier States, and other shade trees and dooryard shrubs for dry and arid

Rockville Plant-Introduction Field Station—Continued.

regions. Owing to the citrus-canker and nematode quarantines, only about half of the plants propagated could be distributed. The stringent methods of inspection and fumigation observed in connection with the greenhouses of this station make it virtually a quarantine station for all material about which there might be a slight suspicion. 91,385 plants were distributed from this garden in the spring of 1916.

Assignment.—David Fairchild, P. H. Dorsett, Peter Bisset, J. M. Rankin.

Proposed expenditures, 1916-17.—\$12,740.

Bellingham Plant-Introduction Field Station:

Object.—Same as Chico station.

Procedure.—Same general procedure as at Chico station. It is proposed to place upon this field station the bulb propagation garden now on rented land, the lease of which expires shortly, and at the start this bulb work will be the most important part of the station. The bulb work will be under the general management of Dr. David Griffiths and will be supported by funds to be provided for out of the appropriation for congressional seed distribution until such time as a special appropriation shall be made for its continuance as a research project of the Office of Pomological and Horticultural Investigations. The station itself will be under the management of a trained manager of this office. It is expected that the Bellingham field station will be especially adapted to the propagation of many plants, particularly from the Orient, in the propagation of which much difficulty has been experienced at the other field stations.

Location.—Bellingham, Wash.

Date begun.—1916.

Results.—Sixty acres have been deeded in trust to the department for this station, and the work of clearing the land and constructing the necessary simple buildings has been begun.

Assignment.—David Fairchild, P. H. Dorsett, Peter Bisset, H. E. Juenemann.

Proposed expenditures, 1916-17.—\$3,000.

Avocado Introduction:

Object.—To introduce, test, propagate, and distribute rare and valuable varieties of avocados (alligator pears), and to establish avocado culture on a commercial basis in the United States.

Procedure.—Better and hardier strains and varieties from other countries are introduced, fruited, and compared with varieties already established and grown in this country.

Cooperation.—Private cooperators in Florida and California.

Location.—Plant-introduction field stations at Miami, Fla., Chico, Cal., and Rockville, Md.

Date begun.—1909.

Results.—Several hundred introductions have been made for propagation, testing, and distribution, including hard-shelled, late-maturing varieties from Guatemala, some of which have already fruited and appear to be of good quality.

Assignment.—David Fairchild, Wilson Popenoe, Edward Simmonds.

Proposed expenditures, 1916-17.—Nominal; included in amounts allotted to field stations.

Udo Introduction:

Object.—To demonstrate the possibility of the successful commercial growing of this Japanese vegetable and to secure the best varieties for cooperative work.

Procedure.—The best strains known are introduced from Japan, propagated, and distributed.

Location.—Plant-introduction field station at Rockville, Md.

Date begun.—1902.

Results.—About 25,000 plants were propagated during the past three years. These and a large number of packets of seed were distributed to persons throughout the United States. Eight named varieties from Japan were introduced and tested at the Rockville station. A large number of people are testing this vegetable in their private gardens, and small amounts have been sold on the markets.

Assignment.—David Fairchild, J. M. Rankin.

Proposed expenditures, 1916-17.—Nominal; included in allotment for Rockville station.

Mango Introduction:

Object.—To encourage the establishment of commercial mango growing in this country.

Procedure.—New varieties of this fruit are introduced, propagated, and distributed. These varieties are also fruited and compared with varieties already grown in this country.

Cooperation.—Private experimenters and cooperators in Florida and California.

Location.—Plant-introduction field stations at Miami, Fla., Chico, Cal., Rockville, Md., Homestead and Miami, Fla., Altadena, Cal., and other points in these States where private experimenters are conducting tests.

Date begun.—1900.

Results.—Over 400 different introductions have been propagated and distributed, resulting in bearing trees and groves scattered throughout Florida. Field investigations have been made in Florida, Cuba, Isle of Pines, and Porto Rico to discover the causes of the failure of certain varieties to bear. Experiments in ringing and girdling the trees to increase their fruitfulness are now being conducted. The distribution of mangos in the spring of 1915 was limited to Dade and Broward Counties, Fla., on account of the citrus-canker quarantine. Three hundred and forty-four plants were distributed from the Miami station.

Assignment.—David Fairchild, Wilson Popenoe, Edward Simmonds.

Proposed expenditures, 1916-17.—Nominal; included in allotments for field stations.

Dasheen Introduction:

Object.—To introduce a tuberous root crop into the warmer, moist sections of the United States, where climatic conditions make the growing of the Irish potato impracticable or uncertain, and especially where the potato can not be grown as a fall crop.

Procedure.—New varieties are introduced from foreign countries and tested in comparison with varieties already grown in this country. These varieties are improved by selection. Large numbers of dasheen tubers are propagated and distributed to private cooperators for planting and for experimental table use. Experiments are conducted to determine the best methods of cooking and serving dasheen tubers, flour, leaves, and, blanched shoots. Limited quantities of tubers are distributed to the domestic-science departments of State universities, to cooking schools, and to leading clubs, hotels, and restaurants, when their cooperation can be secured, in an effort to establish a market for the dasheen.

Location.—Washington, D. C., the plant-introduction field station at Brooksville, Fla., and various points in the Southern and Gulf States.

Date begun.—1905.

Results.—The root-knot situation, which prevented an extensive distribution of dasheens in 1915, is well in hand so far as it concerns the propagation of healthy dasheens. Since the department's stock is grown almost exclusively at the Brooksville (Fla.) station, however, it was deemed inadvisable, on account of the citrus-canker situation, to distribute dasheens in any of the States in which citrus trees are grown. This has prevented distribution in 1916 in all the States to whose climate the dasheen is best adapted. About 12,000 pounds of dasheens were distributed for experimental eating purposes in eastern and northern cities, and as a result the small market of the preceding season has increased considerably. One eastern market took more than 70 barrels. A large number of cooking tests were made in connection with the selection work and to determine the quality of dasheens produced in various sections of the South. Storage tests indicate that long-continued temperatures as low as 41° F. are fatal to dasheens but that they will keep well at 50° to 60° F.

Assignment.—R. A. Young, J. E. Morrow.

Proposed expenditures, 1916-17.—\$3,040.

Bamboo Introduction:

Object.—To introduce and establish the edible and timber bamboos in sections of the United States where these plants will succeed and to encourage their planting in commercial quantities.

Procedure.—The bamboo plants are introduced and propagated and the rhizomes distributed. Cooperation is arranged with American manufacturers using bamboo in connection with the utilization of domestic-grown cane. The utilization of bamboo shoots as a vegetable is being exploited.

Cooperation.—The McIlhenny Co., Avery Island, La.

Bamboo Introduction—Continued.

Location.—Plant-introduction field stations at Brooksville, Fla., Chico, Cal., and Rockville, Md., and Avery Island, La.

Date begun.—1907.

Results.—Over 100 different introductions have been tested. Six acres of timber bamboos are now growing at the Brooksville station. Experimental plantings of both edible and timber bamboo have been made at Avery Island, La., and edible shoots have been obtained from this plantation for trial. It is evident that in Louisiana alone thousands of acres of land are adapted to the cultivation of the bamboo.

Assignment.—David Fairchild, P. H. Dorsett, Peter Bisset, S. C. Stuntz, J. E. Morrow.

Proposed expenditures, 1916-17.—Included in allotments for field stations.

Litchi Introduction:

Object.—To introduce and establish this Chinese fruit in the United States.

Procedure.—Improved varieties are introduced and seedling and budded plants propagated and distributed.

Location.—Plant-introduction field stations at Miami, Fla., Chico, Cal., and Rockville, Md.

Date begun.—1907.

Results.—About 50 different introductions have been propagated and distributed. Trees growing at Oneco and Tampa, Fla., may prove this tree to be hardier than expected. A considerable number of seeds has been imported, and the propagation of this fruit is now being pursued.

Assignment.—David Fairchild.

Proposed expenditures, 1916-17.—Nominal; included in allotment for field stations.

Chayote Introduction:

Object.—To place better strains and varieties in the hands of cooperators and experimenters throughout the Southern States and to exploit this vegetable on the Northern market.

Procedure.—This project involves the introduction, propagation, and distribution of better and improved strains of chayote and their culinary testing.

Location.—Plant-introduction field station at Brooksville, Fla.

Date begun.—1910.

Results.—A large number of plants and seeds has been introduced and distributed to experimenters. The best varieties of chayotes have been grown and tested at the Brooksville station. Several hundred fruits have been distributed to experimenters in Florida. About 2 acres were planted this spring (1916) at Brooksville for experimental test. Sixty-six crates were sent to Washington, and the exploitation of this vegetable was advanced by serving it at various functions.

Assignment.—David Fairchild, Nathan Menderson.

Proposed expenditures, 1916-17.—Included in allotment for Brooksville station.

Almond Introduction:

Object.—To secure and introduce better varieties of almonds.

Procedure.—The work consists of the introduction, propagation, and distribution of improved varieties.

Location.—Plant-introduction field station at Chico, Cal.

Date begun.—1907.

Results.—The hard-shelled Spanish almonds have been introduced and tested, and experiments are under way with Chinese bush almonds, new possibilities for the Southwest. Over 100 different introductions have already been made, several of which show promise of being improvements over old varieties.

Assignment.—David Fairchild, R. L. Beagles.

Proposed expenditures, 1916-17.—Nominal; included in allotment for Chico station.

Tung Tree Introduction:

Object.—To introduce, establish, and grow tung (or wood-oil) trees commercially in the United States.

Procedure.—Introductions are made of the seeds, which are then propagated and the seedlings distributed. An attempt to increase the acre yield of oil by selection and budding is being made.

Location.—Plant-introduction field stations at Rockville, Md., and Chico, Cal.; and various points in Florida, California, Alabama, and Georgia.

Date begun.—1905.

Tung Tree Introduction—Continued.

Results.—A large quantity of seed has been secured and is being propagated, and it is intended to make a wide distribution of 1-year-old seedlings in the spring of 1917. Three thousand Japanese and 5,500 Chinese tung trees were grown at the plant-introduction field station in 1915 for distribution this spring. Several private plantings, the largest consisting of 40 acres, are under supervision near Tallahassee, Fla. Some 3-year-old specimens give promise of being heavy producers. The trees have shown themselves adapted to poor clay soils.

Assignment.—David Fairchild, R. A. Young.

Proposed expenditures, 1916-17.—Included in allotments for field stations.

Introduction of Chinese Jujubes:

Object.—To introduce this valuable hardy orchard fruit into the semiarid sections of the United States.

Procedure.—The different varieties of this valuable fruit (*Zizyphus jujuba*) collected and sent in by Mr. Frank N. Meyer, the bureau's explorer in China, are being propagated and distributed.

Location.—Plant-introduction field stations at Rockville, Md., and Chico, Cal.

Date begun.—1910.

Results.—The tree shows itself well adapted to extremely hot weather but makes no growth in regions with cold nights. Prepared Chinese jujubes are as palatable as dates. A careful investigation has been made of the jujube industry in China, including the methods of culture, preparation for market, and varieties grown. Over 50 varieties of this new fruit have been introduced, including practically seedless forms and large-fruited, fine-flavored varieties. Five hundred and forty-six grafted plants were distributed to experimenters in the spring of 1916. Seedlings have fruited when 2 years old.

Assignment.—David Fairchild, P. H. Dorsett, Peter Bisset.

Proposed expenditures, 1916-17.—Included in field-station allotments.

Introduction of Carob Trees:

Object.—To import, propagate, and distribute the most promising productive varieties of this important forage tree, and to determine the best pollinating varieties and the best methods of establishing orchards in this country.

Procedure.—The best known varieties and highest yielding strains are imported from Spain and other countries of southern Europe. These are propagated and seedlings and budded trees distributed.

Location.—Plant-introduction field station at Chico, Cal.

Date begun.—1910.

Results.—The best Spanish, Portuguese, Algerian, and Grecian varieties have been introduced, and seedling trees in southern California have been grafted with these better yielding sorts, which produce sweeter and more nutritious pods, and much interest in this drought-resistant, long-lived forage tree has been aroused.

Assignment.—David Fairchild, P. H. Dorsett, R. L. Beagles.

Proposed expenditures, 1916-17.—Nominal; included in Chico station allotment.

Persimmon Introduction:

Object.—To introduce better yielding, longer lived, larger fruited, and less astringent varieties of the oriental persimmon, *Diospyros kaki*; and to secure the stocks upon which to grow them.

Procedure.—Seeds and cuttings of these forms are introduced from China, Japan, and the oriental tropics. The plants are then propagated and distributed. An investigation of the oriental persimmon industry is made by explorers and correspondents.

Cooperation.—State experiment stations and private experimenters.

Location.—North Carolina, Florida, Georgia, and California.

Date begun.—1910.

Results.—Field investigations were made of the persimmon regions in China by Mr. Frank N. Meyer, agricultural explorer, in conjunction with his explorations in northwestern China, especially of the white-barked persimmon in Chekiang Province, a stock for wet lands. Photographs were secured and arrangements made to secure seeds. Two new varieties were sent in from the Kansu Province. A large collection of Japanese varieties was also imported. In all, over 400 introductions have been made and the plants propagated and distributed, including the large seedless Tamopan variety, remarkable for its nonastringent character.

Assignment.—David Fairchild, Frank N. Meyer.

Proposed expenditures, 1916-17.—Included in field-station allotments.

Introduction of Street and Park Plants:

Object.—To introduce, propagate, and distribute new and rare varieties of shrubs, trees, and other plants for testing to determine their economic importance for civic-improvement purposes and for use in dooryard gardens.

Procedure.—This includes the introduction, propagation, and distribution of new and rare shrubs, trees, and other plant material deemed valuable as additions to those already grown in this country.

Cooperation.—Private experimenters, nursery firms, park superintendents, civic-improvement societies, and other domestic institutions.

Location.—Washington, D. C., and plant-introduction field stations.

Date begun.—1911.

Results.—Hundreds of varieties of trees and shrubs have been introduced, propagated, and placed in experimenters' hands for trial. Those sent out for testing last year include new and rare forms of ornamental vines, such as *Actinidia*, *Clematis*, *Ipomoea*, and *Camoensia*; shrubs and small trees adapted to dooryard and park uses, such as barberries, Japanese flowering cherries, oleasters, honeysuckles, cedars, and hardy roses; and street and windbreak trees, such as oaks, pines, poplars, willows, elms, and tamarisks, many of which are adapted to cultivation in the semiarid regions of the Southwest and the northern Great Plains region.

Assignment.—David Fairchild, Peter Bisset.

Proposed expenditures, 1916-17.—Included in allotments for field stations.

(Date Palm Introduction: Discontinued as a separate project; further work will be handled under projects "Major Foreign Explorations" or "Minor Plant Introductions," in cooperation with the Office of Crop Physiology and Breeding Investigations, of this bureau.)

Introduction of Pistache Nuts:

Object.—To introduce from foreign countries improved varieties of the pistache and to propagate the same for distribution.

Procedure.—Promising varieties are introduced, propagated, and distributed.

Location.—Washington, D. C., and plant-introduction field stations.

Date begun.—1910.

Results.—Superior budded varieties and stocks have been distributed in quantity.

Assignment.—David Fairchild.

Proposed expenditures, 1916-17.—Included in allotments for field stations.

Papaya Introduction:

Object.—To discover and disseminate superior varieties of the papaya with fruit having a better flavor and better shape for shipping purposes than the ordinary seedling papaya; to investigate the best methods of propagating the papaya in order to prevent the deterioration of varieties; to disseminate other species of *Carica* of possible use for breeding with *Carica papaya*; and by the extensive distribution of the plants to discover regions in the Southern States where the papaya may be grown and fruited as an annual.

Procedure.—Includes the introduction, propagation, testing, and distribution of seeds and seedling plants.

Location.—Washington, D. C., and the plant-introduction field station at Miami, Fla.

Date begun.—1912.

Results.—Nearly 200 introductions have been made; thousands of plants (seedlings) and many packets of seed distributed, also grafted plants in limited numbers, to special cooperators; correspondence conducted with manufacturing chemists regarding the establishment of commercial plantings of *Carica papaya* for the production of papain.

Assignment.—David Fairchild, Edward Simmonds.

Proposed expenditures, 1916-17.—Included in allotment for Miami station.

Minor Plant Introductions:

Object.—To introduce, propagate, and distribute seeds and plants other than those covered in specific projects. This project covers improved or unattested forms of the following: Feijoa, loquat, carissa, guava, apples, pears, peaches, and cherries, *Prunus* stocks, wild relatives of economic plants from breeders, and the jaboticaba and other Brazilian fruits.

Procedure.—Seeds, plants, and plant material deemed of sufficient value to warrant their addition to those already grown in this country are introduced, propagated, and distributed.

Minor Plant Introductions—Continued.

Cooperation.—State experiment stations, parks, and other domestic institutions, and private individuals and cooperators.

Location.—Washington, D. C., and plant-introduction field stations.

Date begun.—1910.

Results.—A great quantity of miscellaneous seeds and plants has been introduced, propagated, and distributed.

Assignment.—David Fairchild, P. H. Dorsett, Peter Bisset.

Proposed expenditures, 1916-17.—\$1,200.

Introduction of Annonaceous Fruits:

Object.—To establish as industries the culture of the various subtropical fruit trees belonging to the class Annonaceae and known as sugar apples, cherimolias, sour sops, rollinias, etc.

Procedure.—All the promising species of plants of this class occurring in foreign countries are obtained and tested and established in special gardens. The best sorts are selected and propagated to provide material for plant breeders and other experimenters desirous of planting orchards of these delicious fruits.

Cooperation.—State experiment stations.

Location.—Washington, D. C., and the plant-introduction field station at Miami, Fla.

Date begun.—1916.

Results.—Many introductions of annonaceous plants have been made, and these have been established in orchard form at the Miami field station, where they will be available for breeding and selection purposes. The largest collection in the world of varieties and species of fruit trees of this class has already been assembled there.

Assignment.—David Fairchild, Edward Simmonds.

Proposed expenditures, 1916-17.—Included in allotment for Miami station.

Chinese Wild Peach Stock Introduction:

Object.—To test the Chinese wild peach (*Amygdalus davidiana*) as a stock on which to bud or graft the various stone fruits, such as peaches, apricots, almonds, nectarines, and plums, in order to determine whether it is as long lived, alkali and drought resistant, and otherwise valuable a stock for these fruit trees in America as it has proven to be by centuries of trial in China.

Procedure.—Seeds of this species have been introduced from China and are budded with standard American varieties of stone fruits and tested in various parts of this country by State experiment stations and private experimenters.

Location.—Washington, D. C., and plant-introduction field stations at Chico, Cal., and Rockville, Md.

Date begun.—1916 as a separate project; formerly carried under "Minor Plant Introductions."

Results.—Mr. Frank N. Meyer, agricultural explorer, on visiting nursery gardens near Tientsin, China, found that Chinese gardeners had grafted flowering plums upon a stock which resembled the almond. Upon inquiry he found that the Chinese name for this stock meant literally "mountain peach tree." Further investigations proved this to be *Amygdalus davidiana*. Approximately 3,000 pounds of seed, together with specimens and photographs, were sent in by Mr. Meyer. Plants were grown from these seeds and distributed all over this country. These *davidiana* peach stocks have been tested in various places in the United States, as Chico, Cal., Ames, Iowa, and San Antonio, Tex., and have proven hardy on the northern edge of the peach belt of Iowa and drought and alkali resistant in central Texas and in Arizona and California. A large stock of plants is now being propagated at the Chico field station for distribution next spring. Experiments which have been conducted since 1905, when this remarkable wild peach was first introduced, have proven this plant to be so promising as a stock for practically all stone fruits (cherries excepted) for semi-arid regions that it is considered important enough to handle it as a specific project.

Assignment.—David Fairchild, P. H. Dorsett, Peter Bisset, Frank N. Meyer.

Proposed expenditures, 1916-17.—Included in field-station allotments.

Total, Plant-Introduction Field Investigations, \$43,120, including \$15,420 statutory.

Total, Foreign Seed and Plant Introduction, \$107,080, including \$36,680 statutory.

[Research.]

FORAGE-CROP INVESTIGATIONS.**Supervision:**

Object.—To supervise the investigational work in connection with forage-crop production and perform administrative and routine clerical work incidental thereto.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—C. V. Piper.

Proposed expenditures, 1916-17.—\$16,640.

Alfalfa Investigations:

Object.—To test and develop by breeding and selection and to establish new varieties of alfalfa, especially hardy and drought-resistant strains suitable for the Northwest, and to extend the profitable culture of alfalfa in the East.

Procedure.—In conducting the investigations indicated above, a definite plan has been adopted so that the same methods can be followed at the various points where the work is being done. In conducting the investigations, sufficient replication and a sufficient number of checks are employed to make the results dependable. No experiments are outlined unless the results obtained may answer problems of definite agronomic importance. The factors which determine the work to be done are the immediate needs of the section and the adaptability of the section to the solution of the problem.

Cooperation.—Colorado, Montana, Kansas, and Texas experiment stations and private individuals in the East.

Location.—Redfield, S. Dak., Moccasin and Havre, Mont., Aberdeen, Idaho, Rocky Ford, Colo., Chico, Cal., Hays, Kans., Amarillo and Chillicothe, Tex., and various points in Pennsylvania, New Jersey, Delaware, Maryland, Virginia, and North Carolina.

Date begun.—1905.

Results.—Some of the results of this work are published in Farmers' Bulletins 339 and 495, Bureau of Plant Industry Circular 24, and Department Bulletin 75. Investigations at Redfield, S. Dak., were considerably increased during the year, and seed of selected strains of alfalfa was planted on the station for increase with a view to future distribution. New work was undertaken at Moccasin, Mont., and an assistant placed in charge. This work is very similar to that conducted at Redfield. Cooperation has been entered into with the Colorado Experiment Station and critical studies in seed production inaugurated at Rocky Ford, Colo. The development of heavy-yielding strains of alfalfa, adapted to the warmer portions of the United States, has been inaugurated at Bard, Cal. In this connection a very promising strain has been received from India. It resembles the Arabian and Peruvian varieties but seems to be somewhat superior to either, having the good qualities of both. Reliable data are being accumulated from the tests at the various stations on the yields from various widths of row, effect of cultivation on broadcast stands, and various other methods of treatment. Preliminary experiments have been started with the view of testing the preference of hogs for various strains. The Turkestan variety seems to be more relished by hogs than the others so far tested. Two bulletins have been submitted for publication, one entitled "Medicago Falcata, the Yellow-Flowered Alfalfa," for the Department Bulletin series, and the other, "Commercial Varieties of Alfalfa," for the Farmers' Bulletin series.

Probable date of completion.—1925.

Assignment.—R. A. Oakley, H. L. Westover, Samuel Garver, Leroy Moomaw.

Proposed expenditures, 1916-17.—\$10,900.

Clover Investigations:

Object.—To develop by breeding and selection hardy, heavy-yielding strains of clovers with desirable seed and forage qualities; to determine the relative merits of various species of clover and cloverlike plants; to ascertain the causes and means of overcoming clover failures; and to improve the present methods of clover-seed production.

Procedure.—The relative merits of the different sorts of clover are studied most in detail at cooperative testing stations located at regular State experiment stations. The most promising of these strains are then put out in larger plot and field tests with suitably located cooperative farmers. The cultural requirements of clovers are determined in a preliminary way from a large number of experimental plats at the cooperating experiment stations, and the most

Clover Investigations—Continued.

promising treatments are tried out by numbers of cooperating farmers in the sections in question. The factors which underlie successful seed production are determined in part by a field study of all the harvested seed yields in a given community as compared with the seed failures in the same community, to determine the different methods of treatment and to learn from this study the conditions presented in common by the fields giving the best yields of seed. The work of breeding improved strains of clover is carried out by selecting the most promising individuals from the variety-testing plats and comparing them with individual selections in the various clover fields.

Cooperation.—Indiana, Iowa, and North Dakota experiment stations and individual farmers throughout the northern and eastern parts of the United States.

Location.—Lafayette, Ind., Ames, Iowa, Fargo, N. Dak., Elyria, Ohio, Arlington Farm, Va., and various points throughout the United States.

Date begun.—1905.

Results.—It has been definitely shown that the flower of red clover is self-sterile.

Experiments conducted in cooperation with the Indiana and Iowa experiment stations have all given the same results, and it can now be positively stated that the possibility of securing self-fertile seeds of red clover is excluded. Further selections of desirable plants have been made for the continuance of the work. In cooperation with the Office of Agricultural Technology of this bureau, the improved brush clover-seed stripper has been completed and a patent applied for. In the sweet-clover work information has been secured as to the importance of the plant as a forage crop and also as to where it is grown in an experimental way. This information has been mapped. Experiments are also under way to determine various questions in regard to the sowing and handling of this crop. The encouragement of the production of Ladino white-clover seed has been extended to Michigan and Mississippi. In connection with the problem of clover failure one series of pot experiments has been completed and another series is now under way. Positive results can not yet be announced from these series. Information has also been collected showing that in a great many sections the addition of lime or manure to the land is sufficient to restore its ability to produce good crops of clover. The following bulletins have been published on clovers: Farmers' Bulletins 455, "Red Clover"; 485, "Sweet Clover"; 550, "Crimson Clover: Growing the Crop"; 579, "Crimson Clover: Utilization"; and 646, "Crimson Clover: Seed Production"; and Department Bulletin 289, "Red-Clover Seed Production: Pollination Studies."

Probable date of completion.—1920.

Assignment.—A. J. Pieters, H. S. Coe.

Proposed expenditures, 1916-17.—\$8,820.

Sorghum Investigations:

Object.—To discover the best methods for the culture and utilization of the sorghums as forage crops, determine varietal adaptations and the factors influencing them, improve the crop through the introduction and breeding of new varieties, and determine the proper relation of sorghum to other crops in different sections of the country, so as to extend its use where conditions warrant.

Procedure.—Carefully outlined field tests are carried out, under the supervision of trained assistants, at a number of field stations in the Great Plains area, to determine the proper dates, rates, and methods of seeding, the best time for harvesting, and the best methods of curing sorghum for forage. Comparisons of well-known varieties with new varieties that have been obtained from foreign countries are carried out, and assistance is given the Office of Foreign Seed and Plant Introduction in finding others. The principles underlying the inheritance of certain characters in the sorghums are being studied, and careful selection of types is carried out at each station, with the idea of obtaining varieties better adapted to local conditions. All the wild relatives of the common sorghum are being obtained, as far as possible, and studied in connection with the breeding and classification work. About 800 different introductions of sorghum are being grown at the Bard, Cal., field station and detailed notes obtained for identification and classification purposes. Cooperative experiments designed to determine the silage value of different varieties of sorghum have been encouraged at the State experiment stations. Investigations of the difficulties attending the use of sorghum for pasture and soiling purposes, due to the presence of prussic acid in the green plant, are under way. Especially promising varieties of sorghum are also being tested in cooperation with selected farmers and the State experiment stations.

Sorghum Investigations—Continued.

Cooperation.—Texas and Kansas experiment stations.

Location.—Chillicothe and Amarillo, Tex., Hays, Kans., Bard and Chula Vista, Cal., Redfield, S. Dak., and Biloxi, Miss.

Date begun.—1905.

Results.—Dwarf hegari, a new sorghum variety developed at the Chillicothe field station, has become quite popular, and large acreages of it are being planted in the southern part of the Great Plains. A farmers' bulletin describing this variety and several other promising new sorghum varieties has been submitted for publication. A hybrid between Honey sorgo and Johnson grass has been obtained which appears quite resistant to the red-spot, a disease which is very destructive to Sudan grass in the Gulf coast region. This new plant, which has been named Johnsorgo, will be tested as a hay crop along the South Atlantic and Gulf coasts. A study of the Mendelian characters of sorghums has been completed for the second generation of milo-feterita hybrids at the Amarillo field station, and two years' results have been obtained on the effect of close pollination on sorghum yields at the Hays, Amarillo, and Chillicothe field stations. Sumac sorgo, Blackhull kafir, and Dwarf hegari have been found the best forage varieties for the southern portion of the Great Plains, Red Amber and Orange sorgo and Dwarf Blackhull kafir for the central part, and Red Amber and Dakota Amber sorgo for the northern Great Plains. In the Southeastern States Sumac, Honey, and Orange sorgo are most valuable. Results of earlier work have been published in Farmers' Bulletin 458 and B. P. I. Circular 122.

Assignment.—H. N. Vinall, R. W. Edwards, A. B. Cron, R. E. Getty, H. R. Reed.

Proposed expenditures, 1916-17.—\$6,000.

Dry-Land Forage Crops Other than Sorghums:

Object.—To test all forage crops believed to be of value in dry-land agriculture, improve the most promising crops by breeding, determine the best cultural methods for such crops, and develop proper methods of field experimentation for forage-crop work.

Procedure.—Extensive row tests of both native and introduced plants are carried on at the various field stations in the semiarid region. Those varieties which appear promising are then grown in plot tests, and after this second elimination test the most valuable are given cooperative field tests with farmers. The selection of improved strains, seed production, methods of cultivation, and combinations of legumes and nonlegumes are points of special study. In the development of improved methods of conducting field experiments samples of various sizes were taken, in both the green and field-cured condition, of alfalfa, timothy, sorghum, and a meadow-grass mixture. These samples were first air-dried and then oven-dried, the moisture losses thus determined being used as a basis for formulating a system for correcting forage yields by the use of small samples. At the Chillicothe field station during the past season a field 20 rods square was planted to a uniform strain of sorghum and the forage weights obtained for each one-rod length of row. These weights are to be used in a study of the effect of size, shape, and replications of plots on experimental error in field tests of forage crops.

Cooperation.—Texas, Kansas, and Oregon experiment stations, and individual farmers.

Location.—Hays, Kans., Amarillo and Chillicothe, Tex., Redfield, S. Dak., and Moro, Oreg.

Date begun.—1908.

Results.—Some very promising varieties of millet have been obtained from India and will soon be placed in the hands of farmer cooperators. Two closely related Siberian grasses, *Agropyron cristatum* and *Agropyron desertorum*, appear valuable, especially for pasture purposes, in North Dakota, South Dakota, Montana, and Wyoming. The tepary bean has done well at Hays, Kans., and may prove to be a profitable legume for use in the crop rotations of that section. Earlier data will be found in B. P. I. Circular 80 and Farmers' Bulletin 101. A practical and efficient method of correcting the moisture content and thus standardizing forage yields by the use of air-dried samples has been formulated and described in Department Bulletin 353. Interesting information in regard to the shrinkage of hay and fodder during storage and the actual loss of dry matter, especially in fodder, during curing and storage periods, was obtained in connection with these moisture studies.

Assignment.—H. N. Vinall, R. W. Edwards, A. B. Cron, R. E. Getty.

Proposed expenditures, 1916-17.—\$8,300.

Field Pea:

Object.—To determine the varietal adaptations, agronomic value, and climatic limitations of this crop, discover the best methods for its culture and utilization, increase its value and usefulness through the introduction and breeding of new varieties, and extend its use in localities where conditions warrant.

Procedure.—Rather extensive variety tests have been conducted at a number of field stations and in cooperation with several State experiment stations. Methods of culture are investigated at a few selected points, and farm practice in regard to the utilization of the field pea as a pasture plant are being studied in the San Luis Valley of Colorado, and their utilization as a green manure in California and Texas.

Cooperation.—Montana and Idaho experiment stations; temporary cooperation with the Minnesota, Wisconsin, Michigan, and New York (Cornell) experiment stations.

Location.—Moccasin, Mont., Aberdeen, Idaho, Redfield, S. Dak., San Luis Valley, Colo., San Antonio, Tex., St. Paul, Minn., Madison, Wis., East Lansing, Mich., and Ithaca, N. Y. Extensive tests have also been carried on in past years at Pullman, Wash.

Date begun.—1907.

Results.—Several new varieties have been introduced which are of considerable importance. The Bangalia, an Indian variety, is now grown quite extensively in eastern Washington and northern Idaho. The Carleton, a New Zealand pea, has been found of special value on the dry lands of Oregon. In addition to these, the Kaiser, a German pea, is quite promising, as well as the Chang, a Chinese pea, of which at the present time only very limited quantities of seed are available. As a result of the cooperative tests at the San Antonio (Tex.) field station, considerable interest has been aroused in that region over the possibilities of growing it there as a winter cover and hay crop. Results have been published in Farmers' Bulletin 690, B. P. I. Bulletin 190, B. P. I. Circular 106, and Washington Experiment Station Bulletin 99.

Assignment.—H. N. Vinall, Leroy Moomaw.

Proposed expenditures, 1916-17.—\$800.

Timothy Breeding:

Object.—To secure by breeding and to establish agriculturally improved strains of timothy.

Procedure.—In the timothy-breeding work selections are made in various parts of the country under different conditions and the plants propagated vegetatively in rows. Seed is then saved from these plants in order to determine whether it will breed true to type. Coincident with this, close-fertilized seed is secured and tested in comparison with the open-fertilized seed. Two generations of close-fertilized seed are considered sufficient to secure a homozygous strain. After this has been accomplished the selection is tested under field conditions and, if valuable, the stock of seed is increased for testing among farmers.

Cooperation.—Ohio Experiment Station.

Location.—Elyria, Ohio.

Date begun.—1905.

Results.—The timothy selections that were growing at New London and Wooster, Ohio, were transferred to Elyria in 1915. Considerable quantities of seed of timothy selection "1576" were produced last year, and with this approximately 20 acres were seeded with a view to include the seed produced from this seeding in the new and rare seed distribution for 1917. It is quite probable that that seed will be largely distributed in Ohio.

Probable date of completion.—1919.

Assignment.—R. A. Oakley, M. W. Evans.

Proposed expenditures, 1916-17.—\$2,500.

Pasture Investigations:

Object.—To determine the best methods of handling pastures so as to secure the maximum carrying capacity.

Procedure.—Tests are conducted to determine the practicability of reseeding permanent meadows without breaking up the sod. A specific pasture experiment is being conducted, in cooperation with the Tennessee Experiment Station, at Crossville, Tenn. Experiments are made which involve tests in cultural treatment, alternate grazing, light and heavy grazing, fertilizing, and reseeding.

Location.—Virginia, Tennessee, Missouri, and in States generally east of the Mississippi River.

Pasture Investigations—Continued.

Date begun.—1909.

Results.—A department bulletin entitled "Grazing Industry in the Bluegrass Region" is now in press. Preliminary pasture surveys have been made with a view to considerably enlarge the scope of pasture investigations.

Probable date of completion.—1920.

Assignment.—Lyman Carrier.

Proposed expenditures, 1916-17.—\$3,600.

Sudan Grass:

Object.—To determine the agronomic value and climatic limitations of this newly introduced grass and to develop disease-resistant strains.

Procedure.—Plot tests, designed to indicate its yielding power and the best methods of culture, are conducted on all the forage-crop field stations in the Great Plains and also in cooperation with numerous State experiment stations which, on account of their interest in Sudan grass, have volunteered to conduct a series of experiments outlined by the Office of Forage-Crop Investigations. Many field tests were also carried out by individual farmers under the direction of this office. This year will practically complete the introduction work with Sudan grass. Future work will be largely along breeding lines.

Cooperation.—Temporary cooperation with many State experiment stations, including practically all in the South and Central West, and with large numbers of farmers and agricultural organizations.

Location.—Arlington Farm, Va., College Park, Md., Jackson, Tenn., Clemson College, S. C., Athens, Ga., Gainesville, Fla., Agricultural College and Biloxi, Miss., Baton Rouge, La., Fayetteville, Ark., Columbia, Mo., Chillicothe and Amarillo, Tex., Stillwater, Okla., Hays, Kans., Redfield, S. Dak., Moccasin and Bozeman, Mont., Moro and Corvallis, Oreg., and Chico, Bard, and Davis, Cal.

Date begun.—1909.

Results.—Sudan grass has become a recognized hay crop in the southern part of the Great Plains and in the interior of the Southeastern States, and its use as a catch crop and insurance against hay shortage is widely practiced in the corn belt of the Central and Eastern States. The potential value of Sudan grass to the farmers of the United States at the present time is variously estimated at from \$6,000,000 to \$10,000,000 annually. Much more extensive plantings of this crop would have been made during the past year if the seed had been less expensive. Plenty of seed can now be purchased, however, at a reasonable price. Data on this crop are available in Farmers' Bulletin 605 and B. P. I. Circular 125.

Assignment.—H. N. Vinall, R. W. Edwards, A. B. Cron, R. E. Getty, S. Garver.

Proposed expenditures, 1916-17.—\$1,000.

Rhodes Grass:

Object.—To determine the agronomic value of this newly introduced foreign grass.

Procedure.—Investigations are being conducted along the line of cultural treatment, including cultivation and the use of fertilizers.

Cooperation.—Most of the southern experiment stations are carrying out plot work on plans prepared by the department.

Location.—The cotton-growing States and Arlington Farm, Va. Most of the work is conducted in Florida.

Date begun.—1910.

Results.—Rhodes grass is apparently gaining in popularity in Florida and promises to hold an important position among the forage crops of that State. A recent interest in Natal grass has detracted attention somewhat from Rhodes grass, but it is still popular, and investigations of a general nature are being continued.

Probable date of completion.—1920.

Assignment.—C. V. Piper, R. A. Oakley.

Proposed expenditures, 1916-17.—\$500.

Cowpeas:

Object.—To test and select new and improved varieties, breed varieties resistant to wilt and nematode and which will produce better seed and forage, and investigate the best methods of harvesting and thrashing the seed.

Procedure.—New introductions, selections, and hybrids are tested at Arlington Farm, Va. The most promising of these are put out with the southern experiment stations.

Cowpeas—Continued.

Location.—Arlington Farm, Va., Rocky Mount, N. C., and Monetta, S. C.

Date begun.—1905.

Results.—Data in Farmers' Bulletin 318, B. P. I. Bulletin 229, and B. P. I. Circular 124. A very considerable amount of work has been carried on with varieties, selections, and hybrids of this crop. Seed of early varieties of *Vigna catjang* have given excellent results throughout the cowpea belt under rather adverse conditions. Hybrids with either Iron or Brabham as one of the parents have given considerable promise as highly resistant strains of high forage and seed production in the wilt and nematode lands of South Carolina. Selections from Groit-Brabham hybrids show seed quite different from either parent and give most promising results in forage and seed yield and in resistance to wilt and nematode. Other hybrids where the Early Buff and Buff Catjang, promising early varieties, were combined with the Brabham, New Era, Groit, and Iron varieties, have given some promising early selections. These early strains seem especially suited to more northern conditions, but are also suitable for southern localities where an early variety is desired. A large amount of work is being done to breed pure strains of the most promising of the hybrid selections. Investigations have been conducted in North Carolina, Louisiana, and at Arlington Farm, Va., concerning methods of culture, variety tests, and dates of planting for forage and seed. Rather extensive work has been continued with the Groit, Brabham, Early Buff, Catjang, and Monetta varieties. Throughout the wilt and nematode lands the Brabham and Monetta have proved very promising. The Brabham is now quite generally listed by seedsmen. The Groit has proved a very promising variety, both for forage and seed, wherever grown and is now listed by the large seedsmen. The Early Buff has been distributed throughout the Central and Northern States and found superior in forage and seed yield to many of the early commercial varieties.

Probable date of completion.—1920.

Assignment.—W. J. Morse.

Proposed expenditures, 1916-17.—\$2,500.

Soy Beans:

Object.—To extend the culture of soy beans in new regions, determine the most valuable of the numerous varieties, secure new and improved varieties by breeding, determine the best methods of culture and harvesting, and bring about an increased use of the crop not only for forage but for oil-seed production.

Procedure.—New introductions, selections, and hybrids are tested at Arlington Farm, Va. The most promising of these varieties and selections are tested out in cooperation with State experiment stations. Seed of the most promising varieties and selections is grown on a field scale, so that seed may be had for a more general distribution.

Cooperation.—Extensive tests with North Carolina, Missouri, and Georgia experiment stations, and variety tests with nearly all State stations and with reliable farmers in different sections of the country.

Location.—Arlington Farm, Va., and various points in the Northern, Southern, and Central States.

Date begun.—1905.

Results.—Farmers' Bulletin 372 and B. P. I. Bulletin 197 have been published; a publication treating on the manufacture and uses of oil, cake, and other products of the soy bean is now in press; and other publications on the culture and further uses of the crop are in preparation. The work with soy beans has been quite extensive along the following lines: Variety testing, breeding, methods of culture, utilization, and extension. During the past season over 400 introductions and 200 selections and hybrids were tested. About 30 of the earliest were tested in all of the Northern and border States, and several give most promising results as forage and grain varieties. Variety tests in the wilt and nematode lands show three varieties highly resistant to these diseases. Considerable work has been carried on in selection and hybridizing and promising results obtained. The shattering of the pods at maturity is an important problem, and hybrids have been made with the result that nonshattering strains have been developed. In addition to the forage value of the soy bean, analyses are being made of varieties to find strains high in percentage of oil. Selections from a variety obtained from Manchuria show a range of oil from 20 to 25 per cent. The extension work has been principally with Tokio, Manchu, Biloxi, Barchet, Haberlandt, Wilson, Peking, Arlington, and Virginia varieties. The Virginia has given most excellent results as a forage variety throughout the South.

Soy Beans—Continued.

The Tokio and Haberlandt are heavy grain yielders and have given most excellent results. The Manchu and Black Eyebrow are early Manchurian varieties, and tests have shown them to be most excellent grain and forage varieties for the Northern States. The Barchet and Biloxi varieties have given especially promising results in the rice lands of the Gulf States. At the present time old commercial varieties have been almost wholly replaced by varieties and selections put out by the department.

Probable date of completion.—1920.

Assignment.—W. J. Morse.

Proposed expenditures, 1916-17.—\$3,000.

Velvet Beans:

Object.—To compare different species and varieties of velvet beans, obtain new varieties by breeding, and extend their culture farther north by securing early strains.

Procedure.—Promising new and improved varieties are tested at various southern experiment stations, and the most promising are given a wide distribution.

Cooperation.—Florida Experiment Station, and variety tests with several other southern experiment stations.

Location.—Biloxi, Miss., and Brooksville and Miami, Fla.

Date begun.—1905.

Results.—Data in B. P. I. Bulletin 179. The Early Florida velvet bean is the best early variety yet secured. Various new hybrids are decidedly promising. Late varieties intercrossed give rise to early varieties. The securing and introduction of early varieties of velvet beans have greatly extended the area in which this crop may be grown profitably. About 20 distinct species have been tested and numerous new varieties secured by hybridization. Earliness arises by sporting in several species, and this is probably the origin of the Early Florida variety. Some of the late sorts are superior for southern Florida. During 1916 seed of the most valuable species are being distributed in the areas to which they are adapted. Technical studies are being continued.

Probable date of completion.—1920.

Assignment.—S. M. Tracy.

Proposed expenditures, 1916-17.—\$2,000.

Vetches:

Object.—To test all the different varieties of this crop and to breed improved strains.

Procedure.—Breeding work is conducted, experiments made with different varieties to ascertain their value, and methods of culture studied.

Cooperation.—Informal cooperation with the Oregon Experiment Station and with farmers.

Location.—Chico, Cal., Corvallis, Oreg., and Arlington Farm, Va.

Date begun.—1905.

Results.—A large amount of agronomic data has been obtained concerning the agricultural value of numerous species of *Vicia*. The most striking result of the investigations has been the discovery of the high value of purple vetch on the Pacific coast, especially for use as a green-manure crop in California. Seed of this vetch can be secured in Europe more cheaply than that of common vetch, which heretofore has been the principal variety used. Other important vetches disclosed by these investigations are woolly-podded vetch, which has about the same value as hairy vetch, and bitter vetch, which under California conditions produces much larger crops of seed than any other species. Publications issued: Farmers' Bulletins—515, "Vetches," and 529, "Vetch Growing in the South Atlantic States." During 1916, in cooperation with the Oregon Experiment Station, extensive plantings of vetches for testing and breeding have been made at Corvallis. For the first year's work the most promising result secured was the successful hybridizing of *Vicia angustifolia* and *Vicia sativa*. From an agronomic standpoint *Vicia angustifolia* has much higher merit in the South than *Vicia sativa*, but its seed habits are poor, so that heretofore the seed has been expensive. It is hoped from these hybrids to get a variety with the good seed habits of *Vicia sativa* combined with the good qualities of *Vicia angustifolia*.

Probable date of completion.—1920.

Assignment.—Roland McKee.

Proposed expenditures, 1916-17.—\$3,000.

New Forage Crops:

Object.—To test new grasses and legumes of probable forage value.

Procedure.—Various forage plants of possible forage value are tested in the field in rows and plots, and such as possess promise are thoroughly tried out.

Cooperation.—Various State experiment stations.

Location.—Arlington Farm, Va., Chico, Cal., Biloxi, Miss., and various experiment stations.

Date begun.—1906.

Results.—From the studies carried on under this project there has resulted the introduction of a number of valuable new forage crops, including Sudan grass, giant Bermuda grass, carib grass, Zulu grass, and Toda grass. Many agronomic data have also been secured concerning such forage crops as kudzu, hyacinth beans, algaroba, mung beans, and others. The most promising new forage plant tested during the past year was carib grass, an introduction from Brazil. On muck lands in Florida this has outyielded Para grass, the best grass previously known under such conditions, by about 50 per cent.

Assignment.—C. V. Piper.

Proposed expenditures, 1916-17.—\$4,580.

Range and Dry-Land Pasture Investigations:

Object.—To improve the carrying capacity of pastures in the dry-land regions and of natural ranges.

Procedure.—Cultural experiments are conducted on pastures in dry-land regions, and plants that promise to increase natural pasturage on range lands are introduced, tested, and distributed.

Location.—Various field stations of the Bureau of Plant Industry, mostly in the semiarid regions.

Date begun.—1902.

Results.—The main results of this work have been published as follows: B. P. I. Bulletins—4, "Range Improvement in Arizona"; 15, "Forage Conditions on the Northern Border of the Great Basin"; 38, "Forage Conditions and Problems in Eastern Washington, Eastern Oregon, Northeastern California, and Northwestern Nevada"; 67, "Range Investigations in Arizona"; and 117, "The Reseeding of Depleted Range and Native Pastures"; and Department Bulletins—201, "Native Pasture Grasses of the United States," and 211, "Factors Affecting Range Management in New Mexico." Other results to be published include studies in the carrying capacity of southwestern ranges, changes in the vegetation on range lands, and chemical and botanical studies of range plants. In the reorganization of the work definite agronomic studies of dry-land pastures have been planned and arrangements made for the introduction and testing of numerous dry-land plants.

Assignment.—David Griffiths.

Proposed expenditures, 1916-17.—\$4,000.

Cactus Investigations:

Object.—To study the cactus plant and its use as a forage crop and as human food.

Procedure.—Information is gathered concerning the use of cactus as forage for stock and as human food. Feeding experiments with beef and dairy cattle are conducted. A study is made of the distribution of the economic species of cactus, and experiments are made in the propagation of the more desirable species. Cactus plantations are made in cooperation with State experiment stations and with farmers.

Cooperation.—Office of Farm Management.

Location.—Mainly in the Southwest and in Mexico.

Date begun.—1902.

Results.—The main results of this work thus far published are as follows: B. P. I. Bulletins—74, "The Prickly Pear and Other Cacti as Food for Stock"; 102, "Summary of Recent Investigations of the Value of Cacti as Stock Food"; 116, "Tuna as Food for Man"; 140, "Spineless Prickly Pears"; and 177, "Protected Stock Range in Arizona"; Farmers' Bulletin 483, "The Thornless Prickly Pear"; and Department Bulletins—31, "Behavior under Cultural Conditions of Species of Cacti Known as Opuntia," and 208, "Yields of Native Prickly Pear in Southern Texas"; also numerous technical articles in outside publications. Economically, the work has furnished the basis for a rational use of cacti as forage and otherwise. Botanically, a very large body of data has been secured on the classification, culture, variation, and adaptation of cacti of possible economic value.

Probable date of completion.—1920.

Assignment.—David Griffiths.

Proposed expenditures, 1916-17.—\$6,400.

Weed Investigations:

Object.—The study of weeds, to the end of securing their most satisfactory control by tillage and other methods.

Procedure.—Field surveys are made to determine the relation of farm practices to the distribution, growth, and control of weeds. Experiments are conducted to determine the efficiency of various methods of control or eradication.

Location.—Permanent station, Washington, D. C.; investigations conducted throughout the United States.

Cooperation.—Virginia Experiment Station and farmers in various States.

Date begun.—1905.

Results.—The general results thus far secured have been published as follows: B. P. I. Document 416, "The Wild Onion"; B. P. I. Circular 94, "The Mangum Terrace in its Relation to Efficient Farm Management"; B. P. I. Bulletin 257, "The Weed Factor in the Cultivation of Corn"; Farmers' Bulletins—297, "A Method of Eradicating Johnson Grass"; 368, "The Eradication of Bindweed, or Wild Morning-Glory"; 464, "The Eradication of Quack-Grass"; 545, "Controlling Canada Thistles"; 610, "Wild Onion: Methods of Eradication"; 660, "Weeds: How to Control Them"; and 687, "Eradication of Ferns from Pasture Lands in the Eastern United States"; and Department Bulletin 320, "Farm Practice in the Cultivation of Corn."

During the past fiscal year Farmers' Bulletin 687 was published, which gives methods of eradicating ferns from pastures in eastern United States; also Department Bulletin 320, which gives farm tillage practices employed in growing corn throughout the corn belt. The field survey of the tillage practices in the cultivation of cotton in representative areas of the cotton belt has been completed and a manuscript submitted for publication. A survey of the tillage practices employed in growing potatoes has been completed and a manuscript is now being prepared for publication. Cooperative experiments on the weed factor in the cultivation of crops are now being continued. The results of these investigations will be ready for publication after another season. Studies in the eradication of shrubby cinquefoil and other shrubby plants which are troublesome in pastures have been completed and a manuscript prepared. Field investigations and cooperative experiments are being conducted to determine methods of controlling field hawkweed. Studies of the use of various chemical plant poisons for destroying vegetation have been continued. Experiments to determine methods of eradicating noxious weeds in lawns are being continued. A general study of pasture weeds is being made with a view to determine feasible methods of control or eradication. Some investigations have been made with nutgrass to determine methods for its control.

Assignment.—H. R. Cates, L. W. Kephart.

Proposed expenditures, 1916-17.—\$8,440.

Total, Forage-Crop Investigations, \$92,980, including \$12,060 statutory.

[Extension.]

SEED DISTRIBUTION.**SUPERVISION.****Supervision:**

Object.—Supervision of administrative details relating to the purchase and distribution of vegetable, flower, cotton, tobacco, lawn-grass, and drought-resistant field seeds, bulbs, and plants; handling congressional correspondence and franks, and supervision of the personnel of the office.

Procedure.—This work is carried on in three sections, one section of the office taking care of the details in connection with the purchase and distribution of vegetable, flower, cotton, tobacco, and lawn-grass seed, and bulbs; a second section taking care of the congressional correspondence in connection with the distribution of the vegetable, flower, and lawn-grass seed; and another section taking care of the details relating to the purchase and distribution of drought-resistant field seeds and the handling of the congressional correspondence in connection therewith.

Location.—Washington, D. C.

Date begun.—Distribution inaugurated in the Patent Office in 1839, transferred to the Division of Agriculture in the Interior Department in 1862, in 1888 transferred to the newly created Department of Agriculture, and in 1902 placed in the Bureau of Plant Industry.

Assignment.—R. A. Oakley.

Proposed expenditures, 1916-17.—\$28,340.

CONGRESSIONAL DISTRIBUTION.

Vegetable and Flower Seeds:

Object.—Purchasing, testing, packeting, franking, assembling, and mailing vegetable and flower seed for congressional distribution.

Procedure.—All seeds are purchased through competitive bids obtained from the principal seed growers and dealers in this and foreign countries. All purchases are made subject to satisfactory appearance, purity, germinability, and trueness to varietal name or type. The testing of samples of seed to ascertain its purity and germinability is done by experts in the Seed-Testing Laboratory both before and after the shipment of the bulk seed. The seeds are packeted, assembled, and mailed by contract, at a daily output of 134,000 packages.

Location.—Washington, D. C.

Date begun.—Patent Office, 1839; Division of Agriculture, Interior Department, 1862; Department of Agriculture, 1888; Bureau of Plant Industry, Department of Agriculture, 1902.

Results.—The distribution of standard varieties of vegetable and flower seeds of known value and of the best quality. Data published in B. P. I. Circular 100, "Distribution of Seeds and Plants by the Department of Agriculture." During the past fiscal year 16,204,000 packages of vegetable and flower seed were distributed.

Assignment.—R. A. Oakley, J. E. W. Tracy.

Proposed expenditures, 1916-17.—\$236,520.

(**Cotton Seed:** Discontinued. The distribution of cotton seed during the fiscal year 1917 will be made under the project "Purchase and Distribution of New and Rare Seeds.")

Tobacco Seed:

Object.—Purchasing, testing, packeting, franking, and mailing tobacco seed for congressional distribution.

Procedure.—The varieties of tobacco to be included in the distribution are selected by the Office of Tobacco Investigations, and the fields from which the seed is obtained are inspected from time to time by the experts of that office. Plants true to type and of the highest grade are selected and bagged, and seed thus obtained is used in the distribution.

Location.—Washington, D. C.

Date begun.—1902.

Results.—During the past year 3,000 packages of tobacco seed were distributed.

Assignment.—R. A. Oakley.

Proposed expenditures, 1916-17.—\$200.

Lawn-Grass Seed:

Object.—Purchasing, testing, packeting, assembling, and mailing lawn-grass seed for congressional distribution.

Procedure.—All seed is purchased on competitive bids, and, before acceptance, is tested for purity and germinability. For the South, Bermuda-grass seed is furnished for lawn making, while for the other sections of the country a mixture of Kentucky bluegrass, redtop, perennial rye-grass, and white clover is supplied. A circular giving full directions for making and maintaining a lawn accompanies each package of seed.

Location.—Washington, D. C.

Date begun.—1902.

Results.—During the fiscal year 1916, 14,000 packages of lawn-grass seed were distributed.

Assignment.—R. A. Oakley.

Proposed expenditures, 1916-17.—\$2,000.

Strawberry Plants:

Object.—Congressional distribution of strawberry plants.

Procedure.—Quotations are obtained from a number of the principal growers, and orders are placed during May for the delivery of the required number of plants during the latter part of November.

Location.—Washington, D. C.

Date begun.—1902.

Results.—During the past year 6,400 packages of strawberry plants were distributed, comprising 96,000 plants of 15 varieties.

Assignment.—R. A. Oakley.

Proposed expenditures, 1916-17.—\$500.

Dutch Bulbs:

Object.—Congressional distribution of Dutch bulbs.

Procedure.—Standard varieties of tulip and narcissus bulbs are purchased on competitive bids, principally from firms in Holland, and distributed on congressional requests.

Location.—Washington, D. C.

Date begun.—1902.

Results.—During the past fiscal year 10,948 boxes of Dutch bulbs were distributed, comprising 112,000 tulip bulbs, of five varieties, and 244,150 narcissus bulbs, of three varieties.

Assignment.—R. A. Oakley.

Proposed expenditures, 1916-17.—\$2,500.

Miscellaneous Seeds and Plants:

Object.—Congressional distribution of miscellaneous seeds and plants.

Procedure.—Miscellaneous seeds and rose bushes, ornamental shrubs, and other plants are purchased on competitive bids and distributed on congressional requests.

Location.—Washington, D. C.

Date begun.—1902.

Results.—The direct result of this distribution has been to encourage the growing of ornamentals about the home.

Assignment.—R. A. Oakley.

Proposed expenditures, 1916-17.—\$4,000.

Seed Cleaning:

Object.—To remove impurities from seeds purchased for congressional distribution and to test seed-cleaning devices.

Procedure.—Improved modern seed-cleaning machines have been procured, together with a full equipment of screens. All vegetable, flower, and field seeds containing impurities are thoroughly cleaned before distribution. Experiments are being conducted in cleaning drug-plant, sugar-beet, and other seeds.

Cooperation.—Drug Inspection Laboratory, Bureau of Chemistry.

Location.—Washington, D. C.

Date begun.—1906.

Results.—Successful methods have been developed for cleaning senna and other drug-plant seeds and celery and sugar-beet seed. During the fiscal year 1916 large quantities of radish, parsnip, and other vegetable seeds, and alfalfa, kafir, milo, feterita, and other field seeds were cleaned before being distributed by the department.

Assignment.—R. A. Oakley.

Proposed expenditures, 1916-17.—\$1,000.

Total, Congressional Distribution, \$275,060, including \$29,020 statutory. This total does not include \$6,500 allotted from the appropriation for the purchase and distribution of valuable seeds to Horticultural Investigations for carrying on the work under the project "Bulb-Growing Investigations."

PURCHASE AND DISTRIBUTION OF NEW AND RARE SEEDS.**Purchase and Distribution of New and Rare Seeds:**

Object.—To disseminate new and rare high-grade seed of crops new to sections where the data of the department indicate such crops to be of considerable promise. Each package contains a sufficient quantity for a preliminary trial, and, where it is at all practicable, the recipient is urged to use the seed for the production of stocks for future plantings. It is believed that if this practice is followed consistently it will result in a material improvement of the crops of the country.

Procedure.—A list of new and rare seeds worthy of special distribution is prepared by the specialists of the bureau. The sources from which such seeds are obtainable and the quantity available for fall delivery are ascertained in advance. Senators and Representatives are advised of the kinds of seed available and suitable for distribution in their respective districts and are asked to submit a list of names of a number of reputable farmers in their districts who would be willing to plant and care for an area large enough to determine the cost of cultivating and harvesting the new crop in their section in conformity with plans outlined by the department. When the reports are received at the close of the season they are referred to the respective offices dealing with the par-

Purchase and Distribution of New and Rare Seeds—Continued.

ticular crops involved for their information and for such follow-up work as they may deem advisable. The officer in charge of the distribution of new and rare field seeds is responsible for the finances and has charge of all matters involved in the purchase, propagation, testing, and distribution of these new and rare field seeds, but always in cooperation with and through the advice of crop specialists of the office interested in the particular crops involved. Each office of the bureau to which any crops included in the distribution belong prepares the necessary cultural directions and report blanks, indicates the quantity of seeds to be included in the package, and takes charge of such reports as may be received from growers.

Location.—Headquarters, Washington, D. C.; distribution throughout the United States.

Date begun.—1914.

Results.—The distribution of these seeds has enabled farmers to procure seed of new and improved crops in sufficient quantities to produce similar stocks for future seeding, thus materially improving the crops of the country.

During the fiscal year 1916, 321,000 packages of seed were distributed, comprising 210,000 packages of seed of new and rare forage crops and 111,000 packages of seed of new and improved varieties of cotton. Each package contained a sufficient quantity for a preliminary trial, and the recipient was urged to use the seed for the production of stocks for future planting. Inclosed in each package of seed was a circular giving full directions for the planting and cultivating of the crop and a report card on which to submit a report to the department on the results obtained with the seed. Seed of the following named crops was included in the distribution: Sudan grass, feterita, Freed sorghum, dwarf Hegari sorghum, Amber sorghum, and Sumac sorghum; Baltic, Canadian Variegated, Dakota-grown, Grimm, Kansas-grown, Montana-grown, and Peruvian alfalfas; Brabham, Groit, Early Buff, and Buff Catjang varieties of cowpeas; Black Eyebrow, Biloxi, Haberlandt, Mammoth Yellow, Manchú, and Tokio varieties of soy beans; Bangalia, Blue Bell, Carleton, Khaba, and Kaiser varieties of field peas; Kursk and Turkestan millets, dwarf milo, Natal grass, Rhodes grass, and a grass mixture for meadow and pasture, crimson and red clovers; Chinese, Yokohama, and Early Florida varieties of velvet beans; and the Columbia, Dixie, Durango, Lone Star, Trice, and Holdon varieties of cotton.

Assignment.—R. A. Oakley.

Proposed expenditures, 1916-17.—\$63,720, including \$3,720 statutory.

Total, Seed Distribution, \$338,780, including \$32,740 statutory.

[Extension.]

DEMONSTRATIONS ON RECLAMATION PROJECTS.**Supervision:**

Object.—To supervise agricultural demonstration work on Government reclamation projects and to conduct office business in connection therewith.

Location.—Washington, D. C.

Date begun.—1914.

Assignment.—F. D. Farrell.

Proposed expenditures, 1916-17.—\$10,200.

Field Demonstrations:

Object.—To encourage and aid settlers on reclamation projects in the development of local agricultural industries by supplying information, making suggestions, and conducting demonstrations relating to agricultural industries and farm practices, and by assisting in the formation and conduct of farmers' cooperative organizations, for the purpose of improving the methods of production and disposal, methods of securing the financial assistance necessary, and bettering agricultural conditions generally.

Procedure.—Field representatives, under the supervision of the Washington office, stationed on the reclamation projects, operate in direct cooperation with the settlers in furtherance of the objects outlined above. Close cooperation is had with the Office of Western Irrigation Agriculture in all the work. On those projects where that office maintains field stations and where this office has field men stationed the two agencies cooperate closely in placing before the farmers the results of the field investigations.

Field Demonstrations—Continued.

Cooperation.—Bureau of Animal Industry, Office of Markets and Rural Organization, Reclamation Service, Office of Public Roads and Rural Engineering, individual farmers, and various farmers' organizations.

Location.—Colorado (Uncompahgre project), Idaho (Boise and Minidoka projects), Montana (Huntley project), Nebraska-Wyoming (North Platte project), Nevada (Truckee-Carson project), Oregon (Umatilla project), Washington (Tieton project), and Wyoming (Shoshone project).

Date begun.—1914.

Results.—During the fiscal year 1915 work was inaugurated on seven projects, on each of which a field man was located to promote the establishment of a definite agricultural industry or a small group of similar industries, by encouraging the farmers to organize into associations and by giving them information and suggestions in regard to the problems met in connection with these industries.

During the year 1916 work was inaugurated on two additional projects—the Uncompahgre in Colorado and the Umatilla in Oregon. On the Uncompahgre project the work is devoted to live-stock industries and on the Umatilla project to the establishment of better methods of crop production, with particular reference to improved methods of irrigation of the sandy soils of the project. A few of the more important features of the work during the current fiscal year are noted below:

On the North Platte project, where the work is devoted to the swine industry, much progress was made in the control of hog cholera. During the six months ending December 31, 1914, there were 81 outbreaks of cholera, while during the entire year 1915 there were only 29 outbreaks. The percentage of hogs lost following treatment was 12.2 in 1915, as compared with 16.1 during the previous year. Because of the more efficient and effective control of hog cholera, it was possible to pay more attention to other problems connected with the swine industry. This work has been devoted to improvements in feeding methods, the bettering of housing facilities, and the promotion of cooperative marketing. Good progress has been made in each of these directions.

On the Truckee-Carson project, where the dairy industry is of greatest importance, the farmers' receipts for dairy products practically doubled in 1915. One of the principal problems associated with the extension of the industry is the importation of good dairy stock, and much time is being devoted to this. During the year 1915 a total of 699 dairy animals were imported to the project. This importation included 30 pure-bred bulls for use in herd improvement. Another important line of work is the control of diseases affecting dairy cows, particularly tuberculosis and infectious abortion. Much progress has been made in connection with the control of the latter, due to a constantly increasing understanding on the part of the farmers of the sanitary and quarantine requirements. Some time was devoted to improving the poultry-marketing conditions, which, previous to 1915, had been very unsatisfactory. In the fall of that year, however, the field men succeeded in interesting a number of commission houses on the Pacific coast, and the result was that approximately 100,000 pounds of dressed poultry were shipped from the project during the year, at prices ranging from 18 to 23 cents a pound. In order to make it possible for the farmers to improve their methods of feeding dairy cattle, experiments were inaugurated on 12 farms, in cooperation with the Office of Western Irrigation Agriculture, for the purpose of determining crop varieties and cultural methods suited to the production of root and grain crops in supplementing alfalfa. The results secured in 1915 on these tests were very satisfactory.

On the Minidoka project a large proportion of the work has been devoted to hog-cholera control. This work is conducted in cooperation with the Bureau of Animal Industry. During the year 1915, 183 suspected cases were investigated, and treatment was applied to 40 herds, including 3,129 hogs, of which only 82, or 2.62 per cent, died following treatment. The efficient control of the disease on this project results largely from the fact that anti-hog-cholera associations have been organized in each of the 19 school districts on the project. These organizations function particularly in connection with the sanitary and quarantine work required in hog-cholera control. Late in 1915 a cheese-factory association was organized and a factory established at the town of Ocequia, and assistance was given the association in the selection, installation, and early operation of the machinery. This cooperative factory is now making good progress. One of the most recent activities is the organization of a grazing association, whereby a number of the water users on the project, each of whom owns a few head of range cattle, will cooperate in utilizing some of the grazing lands in the Minidoka National Forest.

Field Demonstrations—Continued.

On the Tieton project much work is in progress in connection with herd improvement, special attention being given to systematic testing of cows for milk and butter-fat production. At present 28 herds are under test. An important feature of this testing work is that much of it is done by groups of farmers who meet at regular intervals on the different farms for the purpose of testing milk samples and discussing dairy problems. Three outbreaks of hog cholera occurred on the project during the year 1915, but because of prompt action on the part of the field man and the farmers the total loss from this disease was only 6 head. Early in the year 1916 interest was aroused in the extension of the grazing association which was already in operation, looking toward the utilization of the Rainier National Forest area by a large number of Tieton farmers.

On the Shoshone project the work is confined chiefly to dairying and swine production. Special attention is being paid to the improvement of dairy herds through the purchase and use of high-class bulls and through cow-testing work. A grazing association organized in the spring of 1915 had a successful year and will again operate during the grazing season of 1916.

On the Huntley project the work in dairying is related chiefly to herd improvement through cow testing and the use of good bulls, through increased use of irrigated pastures, and through improvements in marketing methods. At present 16 dairy herds are under test. In cooperation with the Office of Western Irrigation Agriculture, much interest is being roused in connection with the use of grass pastures, and the prospects are that several pasture plantings will be made during 1916 at such points on the project as will afford the maximum of demonstrational value. In order to improve the marketing situation, a cooperative cheese factory is now in process of organization, and arrangements have been made with the Dairy Division whereby an expert cheese maker will assist in the selection, installation, and early operation of the machinery and the marketing of the cheese. In connection with the swine industry there has been some activity in cholera control, 44 suspected cases having been investigated during the year 1915 and treatment applied in 8 herds, of which less than 1 per cent was lost following treatment. Cooperative swine-feeding tests were conducted on 7 farms and showed the practicability of using alfalfa pasture as a feed for hogs and of feeding hogs waste by-products of the dairy.

On the Uncompahgre project, where the work is centered around the establishment of live-stock industries, a Holstein club has recently been organized for the purpose of importing some pure-bred Holstein cattle to the project as a part of a campaign for herd improvement. The local cooperative creamery has been assisted in improving the quality of its product, so that the butter-marketing situation has been improved and better prices have been paid to farmers for cream. Interest is being aroused in the matter of cooperative grazing by Uncompahgre water users in the Uncompahgre National Forest. Work is now being inaugurated for the purpose of developing the cooperative marketing of hogs.

On the Boise project much attention was given to the control of hog cholera, which was widespread on the project. During the year 1915, 136 suspected cases were investigated. Treatment was applied in 31 herds, including 2,096 head, of which 89 per cent were saved. In the dairy industry special attention was paid to herd improvement through the use of good bulls and the elimination of inferior cows and to improved feeding methods, including the use of silage and of irrigated pastures. Assistance was given in connection with the construction of 13 silos and the filling of these and a large number of others. Farmers were assisted in the selection of 125 head of cattle, including two pure-bred bulls. A cooperative grazing association has recently been organized for the purpose of utilizing the range lands adjacent to the project in connection with the development of the beef industries.

Assignment.—F. D. Farrell, in charge; Boise project, H. A. Ireland; Huntley project, Carl Christopher; Minidoka project, E. F. Rinehart; North Platte project, Chas. S. Jones; Shoshone project, Don G. Magruder; Tieton project, Roy P. Bean; Truckee-Carson project, L. E. Cline; Uncompahgre project, H. A. Lindgren; Umatilla project, Paul S. Jones.

Proposed expenditures, 1916-17.—\$29,800.

Total, Demonstrations on Reclamation Projects, \$40,000.

FOREST SERVICE.

GENERAL ADMINISTRATION.

Forester:

Object.—Direction and control of all administrative and research activities of the Forest Service.

Procedure.—The administrative work of the Forest Service comprises (1) administration of the national forests, (2) purchase of lands on the watersheds of navigable streams, (3) protection of forested watersheds of navigable streams in cooperation with States, and (4) application of forestry to private timberlands. The research work comprises studies in dendrology, forestry, the utilization of forest products, and the most effective use and improvement of grazing lands. Preference is given to problems arising in the administration of the national forests; but the investigations also include the forest and allied interests of the country at large. The administrative work is conducted through five branches at Washington, of Operation, Lands, Silviculture, Grazing, and Acquisition, respectively, each in charge of an assistant forester, and the Office of the Chief Engineer. A sixth branch, Research, similarly directs the greater part of the research work. While the bulk of national-forest business is transacted in the supervisors' and district offices, transactions of large importance and matters of policy are passed upon by the Forester. General control and uniformity in the application of policies are maintained through field inspection by the Forester and his staff of assistant foresters and forest inspectors.

Location.—Washington, D. C.

Date begun.—Division of Forestry organized as an administrative unit in 1881.

Assignment.—H. S. Graves, A. F. Potter.

Proposed expenditures, 1916-17.—\$28,530.

Chief Engineer:

Object.—Investigations in connection with the development of the water resources of the national forests for water power, irrigation, and water-supply purposes; development of a policy of water-power administration upon national forests; preparation and issuance of term permits for the occupancy of national-forest land for water-power plants and for transmission lines; examination and report to the Department of the Interior upon applications for easements for railroad and irrigation purposes within national forests.

Procedure.—Applications for permits for water-power purposes are filed with the district foresters, examined and reported upon by the district engineers, and referred to the chief engineer for review and approval. Applicants execute stipulations for the protection of Government property, for the payment of annual rentals for national-forest land occupied, for keeping certain records, for complying with State regulations of rates and services, and for submitting the property to State or municipal purchase under certain conditions. Permits for the occupancy of the land are issued by the Secretary. Applications for easements are filed with the General Land Office and submitted to the Forest Service for examination and report by the district engineers and the chief engineer. Final approval is by the Secretary of the Interior upon recommendation of the Secretary of Agriculture.

Cooperation.—Department of the Interior and certain States.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—O. C. Merrill, T. W. Norcross.

Proposed expenditures, 1916-17.—\$15,050.

Accounts:

Object.—To receive and disburse the funds and keep the financial and appointment records of the Forest Service.

Procedure.—The chief of the Office of Accounts at Washington has general charge of all fiscal matters pertaining to the Forest Service and also as fiscal agent immediate charge of accounts work in District 7. Under his general direction the district fiscal agents receive and disburse money, keep financial and appointment records, and supervise the accounting work of the national forests

Accounts—Continued.

in their respective districts. Periodical reports are made by them and their quarterly accounts with the Treasury Department are transmitted through his office for examination and record. General accounts are kept in Washington covering all Forest Service appropriations and allotments to the several districts, while financial transactions in detail are kept by the district fiscal agents. Reports of receipts and expenditures received from all districts and branches of the Forest Service are verified and summary statements prepared monthly, and at other times when required, for the information of the Secretary, the Forester, chiefs of branch, and other officers of the Forest Service directly concerned. Cost statements and other compilations of financial data and annual reports of receipts and expenditures required by the Treasury Department, the Secretary of Agriculture, and by Congress are prepared from records and from district and forest reports.

Location.—Washington, D. C.

Date begun.—1905; present organization established in 1908.

Assignment.—M. E. Fagan, A. W. Smith.

Proposed expenditures, 1916-17.—\$23,620.

Law Work:

Object.—Performance of all legal work on behalf of the Forest Service.

Procedure.—The Solicitor of the Department of Agriculture assigns from his office to each Forest Service district an assistant who becomes a member of the executive force of the district, gives advice on legal matters to the district forester and his assistants, prepares contracts, leases, and other legal papers, and, subject to approval by the Solicitor, renders decisions on legal questions and institutes suits for trespass and other violations of national-forest laws.

Cooperation.—Department of Justice.

Location.—Washington, D. C., and district headquarters.

Date begun.—1903; transferred to Solicitor's office in 1910.

Assignment.—Fred Lees.

Proposed expenditures, 1916-17.—\$13,700 (including \$5,200 allotted to the Office of the Secretary—Forest Appeals).

Operation:

Object.—To administer and supervise the business organization of the Forest Service and the fire protection and permanent improvement work on the national forests.

Procedure.—The assistant forester in charge of the Branch of Operation has general supervision over the organization and business operation of the Forest Service, including both the Washington office and the national-forest districts. This branch is directly responsible for the preparation of estimates and the allotment of funds, the care of quarters, the providing of equipment and supplies, the furnishing of clerical and other assistants, and the supervision of the work of the Office of Geography in the Washington office, and has the general direction of these activities in the national-forest districts. It also has general supervision over the personnel, fire protection, and the construction and maintenance of permanent improvements on the national forests. While direct supervision of the forest forces and the details of operation work in general for their respective districts is the business of the district offices of operation, each in charge of an assistant district forester, general control is exercised by the chief of branch through correspondence and reports and personal inspections by himself and his assistants.

Location.—Washington, D. C.

Date begun.—The Branch of Operation was established in 1907.

Assignment.—James B. Adams, D. D. Bronson, Allen S. Peck, G. G. Anderson.

Proposed expenditures, 1916-17.—\$80,560.

Silviculture:

Object.—Administration of timber sales, timber reconnaissance, timber and fire trespass, reforestation, administrative use, free use, and insect control; also review and approval of working plans for the better administration of the forests and the conduct of the cooperative projects with Eastern States and timberland owners.

Procedure.—The assistant forester in charge of the Branch of Silviculture has general supervision over all activities in connection with the timber business, with the management and use of the forest growth and its protection from depredations by trespassers and by insects and diseases, with the estimates and plans

Silviculture—Continued.

for disposition of timber resources, and with the reforestation of denuded or partially denuded forest areas. Under cooperative agreements he also supervises the preparation and putting into effect of working plans for handling State and private timberlands, for protecting them from fire, etc. Inspectors and expert lumbermen from the Washington office inspect the detail of the work as conducted in the district headquarters offices, in supervisors' offices, and on forest tracts where field operations are being conducted, give advice and assistance where necessary, and standardize, so far as practicable, certain features of the work.

Location.—Washington, D. C.

Date begun.—1907.

Assignment.—W. B. Greeley, R. Y. Stuart, E. E. Carter, Harry Irion.

Proposed expenditures, 1916-17.—\$24,050.

Grazing:

Object.—Administration and general supervision of all matters pertaining to the grazing of live stock upon national-forest ranges and range reserves.

Procedure.—The Branch of Grazing, through the district forester in each of the seven districts, directs the work of handling live stock on the national forests. With the approval of the Secretary of Agriculture, it determines the number of stock which shall be grazed upon the forest ranges and establishes the year-long charge for each class of stock. All trespass cases for grazing stock on national-forest lands without permit, or for violation of grazing regulations, are passed upon by this branch and forwarded to the Solicitor of the department with proper recommendation. In cooperative work with other bureaus of the department, or with other departments, in connection with grazing business, all correspondence is handled through the Washington office. Appeals by permittees from the decision of forest supervisors and district foresters are decided by the Forester. Members of the Branch of Grazing make field and office inspections during the year in order to correct errors in the management of grazing business on the forests or in the handling of routine grazing matters at district headquarters or in the supervisors' offices.

Cooperation.—Bureaus of Plant Industry, Animal Industry, Fisheries, and Biological Survey.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—A. F. Potter, Will C. Barnes, J. W. Nelson.

Proposed expenditures, 1916-17.—\$9,900.

Lands:

Object.—General supervision of all matters relating to the application of public-land laws to lands within national forests and the uses of national-forest lands for purposes other than timber sales and grazing.

Procedure.—The Branch of Lands gives final supervision to administrative activities incident to the classification of land, the listing of areas for homestead settlement, the survey of agricultural lands, and the handling of individual claims to land under the public-land laws. In addition, it passes on certain classes of applications, for long-term leases of areas in the national forests desired for special personal or commercial purposes, and applications for rights of way under various public-land laws. It handles all questions and controversies arising in the various districts, growing out of special permits now in effect on the various national forests, and all questions of boundary changes proposed by presidential proclamations or special acts of Congress, based upon the inclusion or exclusion of public land; and possible changes based upon consolidation of lands through exchanges with States or private owners, in accordance with special acts of Congress. This branch also answers each year thousands of inquiries from prospective homeseekers regarding lands in the national forests and the laws and regulations under which they may be secured and used.

Cooperation.—General Land Office, Geological Survey, Reclamation Service, and Office of Indian Affairs.

Location.—Washington, D. C.

Date begun.—1907.

Assignment.—E. A. Sherman, F. L. Harvey, John D. Jones, W. J. Mangan, Charles H. Squire, B. L. Wheeler.

Proposed expenditures, 1916-17.—\$33,480.

Research:

Object.—Administration of silvicultural investigations, including protection studies, the Office of Forest Investigations in Washington, and the silvicultural experiment stations through the district foresters; forest-products investigations, including all investigations of forest-grown products and of wood-using industries; the products offices in the districts through the district foresters, the Madison laboratory, and the Office of Industrial Investigations in Washington; statistical studies, including the collection of the statistics of wood-using industries; and general economic studies bearing on forestry, forest products, and national-forest management.

Procedure.—The research activities are supervised through the chiefs of offices and the district foresters.

Location.—Washington, D. C.

Date begun.—Research was organized as a separate branch on June 1, 1915.

Assignment.—Earle H. Clapp.

Proposed expenditures, 1916-17.—\$10,720.

Total, General Administration, \$239,610, including \$111,880 statutory.

[Regulation.]

NATIONAL-FOREST ADMINISTRATION.

National-Forest Districts:

Object.—To administer, protect, develop, improve, and maintain the national forests; to promote the full use of their resources and at the same time to prevent waste and preserve the forest cover on the watersheds within the forests.

Procedure.—

(1) ORGANIZATION AND PROTECTION: With a view to promote efficiency in protection and prevent delay in the handling of national-forest business, seven field districts, each with a main headquarters office, have been established as follows: District 1, Missoula, Mont. (Montana, northeastern Washington, northern Idaho, and northwestern South Dakota); district 2, Denver, Colo. (Colorado, Wyoming, the remainder of South Dakota, Nebraska, northern Michigan, and northern Minnesota); district 3, Albuquerque, N. Mex. (most of Arizona, and New Mexico); district 4, Ogden, Utah (Utah, southern Idaho, western Wyoming, eastern and central Nevada, and northwestern Arizona); district 5, San Francisco, Cal. (California and southwestern Nevada); district 6, Portland, Oreg. (Washington, Oregon, and Alaska); and district 7, Washington, D. C. (Arkansas, Florida, Oklahoma, South Carolina, Georgia, North Carolina, Tennessee, Virginia, West Virginia, New Hampshire, and Porto Rico). Under the same general organization as the main office of the Forest Service at Washington and with the district forester at the head, each of the seven district offices has Sections of Accounts, Law, and Engineering and Offices of Operation, Silviculture, Lands, and Grazing. Each office and section has general supervision over its particular line of activities in the district and on all the national forests of the district. Each national forest is administered by a supervisor with a corps of forest rangers and guards. The supervisors in charge of the 151 national forests, the forest examiners-in charge of the 15 new forest areas, and the directors of the 8 field experiment stations report directly to the district foresters. The forest force provided by law consists of 149 supervisors, 81 deputy supervisors, 1,047 forest rangers, and 80 forest guards for periods not exceeding six months. Forest assistants and forest examiners are employed in the various subordinate lines of technical and administrative work on the forest under the direction of the supervisor. The national forests are divided into districts, each with a ranger in charge, and during the season of fire danger additional assistants are provided. On each ranger's district a fire-detection system is maintained by patrol and lookouts. The lookouts occupy fixed observation stations on high peaks, and the patrolmen move on horseback, motorcycles, railroad speeders, or along lake shores on launches over certain routes of travel where risk is concentrated. Guards or firemen with fire-fighting equipment and supplies are stationed at strategic points. All telephones are connected with the main headquarters of the forest. Supervisory officers inspect the work of the men, issue instructions, supply them with equipment, and perfect advance arrangements for quick mobilization and employing, moving, and equipping fire fighters if a fire gets beyond control of the regular force. About 80 per cent

National-Forest Districts—Continued.

of the time of higher field officers is devoted to protection work during the three to five months fire-danger season. To meet the transportation problem the hire of privately owned conveyances is arranged for in advance. In remote regions trains of Government-owned pack horses are used.

(2) **SILVICULTURAL WORK:** (a) **Timber sales:** Commercial timber sales are made in accordance with the act of June 4, 1897; cost sales to homestead settlers and farmers under the act of August 10, 1912. Sales are made by forest officers, the district forester, or the Forester, according to the amount involved. Payment in all cases is made to the district fiscal agent through a designated United States depository. (b) **Timber trespass and fire trespass:** In all cases of timber or fire trespass a thorough examination is made and report submitted to the proper forest officer. Where legal proceedings are not required, trespass cases may be settled (1) by the district forester up to \$500, (2) by the Forester up to \$5,000, (3) by the Secretary of Agriculture when the amount involved is over \$5,000. Legal proceedings are instituted through the Attorney General. (c) **Free use:** Timber is granted free of charge for certain uses specified by law, but the cutting and removal is required to be conducted in accordance with departmental regulations. Free-use permits within certain specified amounts are issued by the district forester, supervisor, and forest ranger. Permits in excess of the district forester's authorization must first be approved by the Forester. (d) **Insect control:** So far as practicable insect infestations are controlled through timber sale, free use, and administrative use. In exceptional cases control projects are inaugurated.

(3) **LANDS WORK:** (a) **Boundary examinations:** Forest areas of doubtful or uncertain value for forest purposes, or of possible agricultural value lying near the boundaries of the forests, are inspected by special land examiners. The maps and reports are transmitted by the forest supervisor to the district forester with appropriate recommendation. The district forester examines them and forwards them to Washington for verification of the status records and submission to the Secretary of Agriculture for final consideration. The proclamation or executive order for elimination is signed by the President. (b) **Claims:** Upon receipt of notice of a claim for patent or when a claim is being asserted without complying with the requirements of the law, a report of all material facts is prepared and forwarded to the district forester for appropriate action. (c) **Administrative sites:** Areas needed for administrative purposes, for logging camps, mill sites, banking grounds, nursery sites, etc., are selected, the boundaries marked and location posted, and a record filed in the district office. Areas desired on unappropriated public domain near the forest are withdrawn by presidential proclamation under the act of June 25, 1910. Sites no longer needed are released and revert to their former status. (d) **Settlement:** The greater part of settlement work under the act of June 11, 1906, is now accomplished through land-classification activities. (e) **Special uses and rights of way:** Rights of way amounting to easements are secured through the Department of the Interior upon recommendation of the Secretary of Agriculture based on reports of national-forest officers. Permits for ordinary special uses, hotels, summer cottages, and miscellaneous commercial purposes are granted by forest supervisors upon application made through the forest rangers. In cases requiring the signature of the district forester or Forester the forest supervisor submits a report on which the action is based. (f) **Occupancy trespass:** The facts relating to an unpermitted occupancy of national-forest lands are obtained by the forest supervisor and submitted by him to the district forester. The latter, if unable to adjust the matter, forwards the report to the assistant to the Solicitor, who, if the facts warrant, recommends that the Department of Justice be asked to institute appropriate proceedings to protect the interests of the United States. Cases of this character have almost entirely disappeared.

(4) **GRAZING BUSINESS:** A constant effort is made to so manage the grazing business on the national forests as (1) to guarantee continued production both of the range and of young forest growth, (2) to utilize all the range to its full capacity, (3) to secure its use to settlers and others most entitled, (4) to improve the range and the quantity and quality of the stock produced, and (5) to secure a fair return to the public—the owners of the range. To insure proper supervision and control of the range, permits are required for all stock grazed on the forests. The district foresters fix the short-term fees for the forests in their respective districts, basing the charges on the year-long rates determined by the Forester. Free permits are granted to settlers for small numbers of stock. Forest rangers are required to see that applications for permits are filed prop-

National-Forest Districts—Continued.

erly and at the right time. They inspect and count the stock taken into the forest. During the season they go over the range to see that the stock are properly distributed, and according to the capacity of the range, and that they are adequately salted. They adjust minor differences between stockmen, locate pasture or drift fences, investigate outbreaks of stock diseases, locate and guard against poisonous-plant areas, assist in exterminating predatory animals, and look after the crossing of transient stock. Experts make studies of the carrying capacity of the range, the restoration of worn-out ranges, the handling of stock, and the effect of grazing upon forest reproduction and growth and upon erosion and watersheds.

(5) **WATER POWER:** Development of the water-power resources of the national forests is encouraged to the fullest degree consistent with the proper protection of the public interest. Permits are required and an annual rental charge is made for the use of the power site based upon an estimated "power capacity." To insure a properly regulated use, Forest Service hydroelectric engineers inspect the sites, measure the stream flow, and examine maps, plans, and other data in connection with the operation of the plant. National-forest administrative officers look after the issue of the permits and collection of fees and see that payment is made for all timber destroyed in construction work.

Cooperation.—Forest users, railroad and telephone companies, owners of timberland, and State organizations.

Location.—District and national-forest headquarters and national forests.

Date begun.—Administration of the national forests was provided for by act of Congress in 1897. The first express appropriation for the protection of the public timberlands was passed in 1872.

Results.—

(1) **ORGANIZATION AND PROTECTION:** During the first 10 months of the fiscal year 1916 the revenues from forest resources were more than 15 per cent greater than for the same period of the previous year and about 300 per cent greater than for 1906, the first full year after the forests were placed under the control of the Department of Agriculture. The expenditures for forest administration and protection, on the other hand, have shown no material increase for the past five years, except for those years when there were unusual expenditures on account of fire suppression. The establishment of the national forests was not primarily to secure revenue, but rather to accomplish certain large public benefits. The greater part of the work, therefore, is not designed to produce revenue, immediately at least, but is devoted to the organization, building up, and protection of the forests and the development and utilization of their resources. As handled, the utilization of the forest resources involves no sacrifice of public interests, but rather is in furtherance of them. The policy is to extend the utilization of the resources in such a way as to meet the purposes of the establishment of the national forests and at the same time to place them ultimately on a complete self-supporting basis. Previous to 1916 the revenues from forest resources in five States more than paid the ordinary operating expenses in those States, and seven other States were not far behind. As the resources are constantly renewed through application of the principles of forestry, the annual revenue received is derived solely from the utilization of the natural increment of production and is not in any way at the expense of the capital invested. Protection of the forests from fire is fundamental, and over 40 per cent of the Forest Service funds are devoted to this purpose. From 2,000 to 7,000 fires are contended with each year, with an average of about 5,000. Ordinarily, with the present organization, about 95 per cent of the fires are extinguished with less than \$100 damage, and about 75 per cent are confined to less than 10 acres.

(2) **SILVICULTURAL WORK:** (a) Timber sales: In 1915 contracts were entered into for the sale of 1,069,578,000 feet of national-forest timber, valued at \$2,650,098.58. A total of 546,508,000 feet of timber, valued at \$1,165,268.43, was cut under sales during the year. (b) Timber and fire trespass: Timber trespass on the national forests continues to diminish in extent. At the end of the fiscal year 1915 there were 54 pending cases. There were also 25 fire-trespass cases pending, as against 26 pending at the close of 1914. (c) Free use: During the fiscal year 1915, 40,015 free-use permits were issued. (d) Insect control: The more important insect-control operations conducted during the fiscal year 1915 were on the Trinity, Stanislaus, and Sierra National Forests in California and the White Top Purchase Area in Virginia.

National-Forest Districts—Continued.

(3) **LANDS WORK:** (a) Boundary examination: The present national-forest boundaries may be considered as essentially permanent, in a general sense. The lines have been drawn so as to include, so far as practicable, only such lands as are valuable for timber or watershed-protection purposes. However, minor modifications are found necessary as a result of the land-classification work, by which the lands within the forests are being examined in detail and permanently classified. As this work progresses and the classification of individual forests is completed, final adjustments in their boundaries are made, and the boundary work is thus very closely related to land classification. During the past year a number of proclamations and executive orders have been issued, making eliminations and boundary changes of this character. (b) Claims: During 1915, 1,456 bona fide claims were acted upon favorably for the claimants, and 164 fraudulent cases were acted on adversely. (c) Settlement: Since the passage of the forest homestead act of June 11, 1906, up to June 30, 1915, there have been listed for entry 18,020 individual tracts with an area of over 1,920,608 acres. (d) Special uses and rights of way: During the fiscal year 1915 there were 18,342 permits in effect authorizing the occupancy of small areas for miscellaneous uses; 10,447 of these were free, and 7,895 paid fees amounting to \$77,810.01.

(4) **GRAZING BUSINESS:** During the first 10 months of the fiscal year 1916 the receipts from grazing fees were nearly 20 per cent greater than during the same period for the previous year. The average receipts from grazing fees approximate \$1,000,000 yearly, involving about 30,000 permits and covering nearly 2,000,000 head of cattle, horses, and swine, and 8,000,000 sheep and goats. In addition, free crossing permits and free grazing permits on account of private land are issued each year for approximately 130,000 head of cattle and over 4,000,000 sheep and goats. Careful management and the adoption of improved methods developed by scientific study and experiment have increased the carrying capacity of the range and have made range conditions in general 25 to 100 per cent better than when the national forests were created. Ranges are now equitably apportioned and each permittee protected in the use of his allotted range, overgrazing and improper use prevented, erosion lessened, forage productivity of denuded areas increased, friction between stockmen eliminated, the spread of stock diseases checked, the ravages of predatory animals reduced, poisonous-plant areas guarded against, quarantine regulations enforced, previously unused ranges utilized, forage resources developed and improved, and new and better methods of handling stock introduced.

(5) **WATER POWER:** The receipts from rental fees for water-power permits during the first 10 months of the fiscal year 1916 were nearly 50 per cent greater than for the same period of the previous fiscal year. On July 1, 1915, 182 permits were in effect for water-power projects, including transmission lines, and 108 permits for transmission lines separately. The total capacity of projects under permit was 1,261,560 horsepower.

Assignment.—F. A. Silcox, Missoula, Mont.; Smith Riley, Denver, Colo.; Paul G. Redington, Albuquerque, N. Mex.; L. F. Kneipp, Ogden, Utah; Coert DuBois, San Francisco, Cal.; George H. Cecil, Portland, Oreg.; William L. Hall, Washington, D. C.

Proposed expenditures, 1916-17.—\$3,733,557, including \$2,060,980 statutory.

[Regulation.]

• AGRICULTURAL SETTLEMENT.

Land Classification:

Object.—The classification and segregation of lands within the national forests that may be opened to settlement and entry under the homestead laws applicable to the national forest or that should properly be eliminated therefrom; also the designation and segregation of all lands required permanently for national-forest purposes.

Procedure.—Thorough field examination forms the basis of the work. This includes the gathering of information relative to the topography, climate, accessibility of the land, and character of the soil; amount, character, and value of the standing timber; value of the land for watershed protection, and the use which is being made of other similar land in the vicinity. Detailed maps are prepared, illustrative especially of the timber and soil conditions, and these maps, accompanied by typewritten reports, are submitted by the local forest supervisor

Land Classification—Continued.

to the district forester for review. After approval by the district forester the reports and maps are acted upon by the Forester and then submitted to the Secretary of Agriculture for final action. Approval by the Secretary results in the official classification of the land involved.

Cooperation.—Bureau of Soils.

Location.—Washington, D. C., district and national-forest headquarters, and national forests.

Date begun.—1912.

Results.—To date 71,728,590 acres have been finally reported upon and classified. Lands found to be "chiefly valuable for agriculture" either have been listed and made available for entry under the forest homestead act of June 11, 1906, or have been eliminated from the national forests and restored to the public domain.

Assignment.—E. A. Sherman, district foresters, and forest supervisors.

Proposed expenditure, 1916-17.—\$106,600.

Entry Surveys:

Object.—The final survey for patent of homesteads on the national forests initiated under the forest homestead act of June 11, 1906, and the act of March 3, 1899.

Procedure.—Upon request by the district forester the United States surveyor general issues to the Forest Service surveyor detailed special instructions for the entry survey of each homestead claim. After the survey is executed in the field the necessary plat and field notes are prepared and submitted to the surveyor general. When approved by him these returns are transmitted to the General Land Office in Washington. If found correct, the survey is accepted by the Commissioner of the General Land Office and photographic copies of the plat (made by the Forest Service) are supplied to the homestead entryman and to the local land office for use in the submission of final proof upon the entry.

Cooperation.—General Land Office and United States surveyors general.

Location.—Washington, D. C., district and national-forest headquarters, and national forests.

Date begun.—1913.

Results.—In the three years since this work was undertaken approximately 1,800 homestead claims have been surveyed in the field. Nine hundred of these surveys have been approved by the several United States surveyors general and 850 of these accepted by the General Land Office. Plats and field notes of the other 900 cases are either in course of preparation or are pending before United States surveyors general.

Assignment.—R. V. R. Reynolds, district foresters, and forest supervisors.

Proposed expenditures, 1916-17.—\$85,000.

Total, Agricultural Settlement, \$191,600, including \$6,000 statutory.

[Regulation.]

FIRE SUPPRESSION.**Fire Suppression:**

Object.—Suppression of fires on the national forests.

Procedure.—A regular system of fire protection is maintained on each national forest, the objects being (1) prevention and (2) suppression. When forest fires can not be handled by the regular force, temporary fire fighters are employed and paid from the special fund for fire suppression. Fire-fighting supplies, freight, hauling, and other expenses incident to fire suppression are also paid from this fund.

Cooperation.—Forest users, settlers, railroad companies, owners of timberland, and State organizations cooperate in both fire suppression and fire prevention.

Location.—National forests.

Date begun.—The first specific appropriation for fire fighting was in 1911.

Results.—During the calendar year 1915, 6,324 fires on the national forests were extinguished with relatively small loss, involving an expenditure of \$212,400 in addition to the salaries of the regularly employed officers who took part in the fire fighting.

Assignment.—Forest supervisors, rangers, and guards.

Proposed expenditures, 1916-17.—\$150,000.

[Regulation.]

MAINTENANCE AND SUPPLIES.**Supply Depots:**

Object.—To purchase, care for, and distribute necessary instruments, equipment, and supplies for the use of supervisors and other forest officers in all branches of the Forest Service.

Procedure.—The property clerks purchase all necessary supplies, instruments, and equipment, maintain a stock of standard supplies and equipment, and issue them to the various forest officers upon requisition.

Location.—Ogden, Utah, and Washington, D. C.

Date begun.—The depot at Ogden was established in 1907.

Results.—By the establishment and maintenance of supply depots the Forest Service has been able to secure reduced prices by wholesale purchase. In field work it has been possible to avoid the delay which would necessarily result from the purchase and shipment of supplies in small quantities to a widely scattered field force. Purchases also have been standardized and a higher grade of equipment secured and at less cost.

Assignment.—R. E. Conner, Ogden, Utah; S. L. McLaurin, Washington, D. C.

Proposed expenditures, 1916-17.—\$169,780.

Property Auditor:

Object.—To keep a record of all the property of the United States in the custody of the Forest Service.

Procedure.—The property auditor keeps a complete record of the value, location, condition, and disposal of all instruments, equipment, supplies, and permanent improvements purchased or constructed by and owned by the Forest Service.

Location.—Ogden, Utah.

Date begun.—1907.

Results.—The property auditor's record enables the Forester to know at any time the location, value, and to a certain extent the condition of all property owned by the Forest Service. As each forest officer is held personally responsible for property issued to him, loss and waste are reduced to the minimum.

Assignment.—J. G. Falck.

Proposed expenditures, 1916-17.—\$9,100.

Total, Maintenance and Supplies, \$178,880, including \$28,480 statutory.

[Research.]

FOREST-PRODUCTS INVESTIGATIONS.**National-Forest Utilization :**

Object.—To assist and advise the district foresters on national-forest market and utilization problems; to make investigations bearing upon administrative problems in cooperation with the Forest-Products Laboratory and the Office of Industrial Investigations.

Procedure.—Advice is furnished to district foresters upon request. Studies and investigations are made in cooperation with the other investigative units of the service subject to the immediate control of the district foresters.

Cooperation.—Various industrial organizations.

Location.—Washington, D. C., Missoula, Mont., Portland, Oreg., and San Francisco, Cal.

Date begun.—1909.

Results.—These are largely in the nature of current advice and assistance to the district foresters in the administration of timber sales and in the dissemination of useful information and assistance to local timber owners, manufacturers, wood-using industries, and the general public. Results in intensive investigations are indicated under the projects which follow.

Assignment.—H. N. Knowlton, H. B. Oakleaf, C. S. Smith, C. A. Kupfer, S. L. Wolfe.

Proposed expenditures, 1916-17.—\$21,560.

Industrial and Statistical Investigations:

Object.—To conduct statistical studies of the production and consumption of lumber and other forest products and of prices for stumpage and market products; to make studies of processes, costs, etc., in various wood-using industries, and of wood utilization and waste; and to cooperate with other Federal departments in the purchase and handling of lumber.

Industrial and Statistical Investigations—Continued.

Procedure.—Statistics are collected annually except when undertaken by the Bureau of the Census. Field studies are made of the wood-using industries; the wood-waste exchange being continued very largely through correspondence. Cooperation is maintained with other Federal departments in the purchase and handling of lumber developed as opportunity offers. Inspection of navy yards, lumber shipments, etc., is undertaken when requested.

Cooperation.—Bureau of the Census, Bureau of Crop Estimates, Panama Canal Commission, Navy Department, War Department, Indian Service, lumber manufacturers' associations and other trade organizations, and various State forestry officials.

Location.—Washington, D. C., and district offices.

Date begun.—1905.

Results.—(1) During the fiscal year 1916 cooperation continued with other departments consisted mainly in the inspection of lumber, preparation of lists of possible bidders, furnishing price data, and in acting as a clearing house for the revision of specifications, advice on the suitability of various woods for specified uses, and advice on methods of handling and storing lumber. Statistics were collected on lumber production, the quantity of wood preservatives used, and the amount of wood treated. The collection of statistics on the wood-using industries by States was continued and reports on three new States published. Records of lumber prices secured in cooperation with district offices, lumber associations, and mills were issued quarterly. Reports were prepared on the box, veneer, and cooperage industries. The wood-waste exchange, instituted to enable manufacturers with waste to get in touch with manufacturers needing small pieces as raw materials, resulted in the utilization of considerable waste in the manufacture of small wooden articles. A field study to determine the quality of southern pines in various regions and markets resulted in data of immediate value to the Southern Pine Association, the Georgia-Florida Sawmill Association, and the American Society for Testing Materials. A bulletin on American woods available for various uses, which will be of value to users of wood in the United States and to commercial agents abroad, was partly completed.

(2) Prior to 1916: Annual statistics on lumber have been obtained since 1905 and figures on other forest products until 1911. Data obtained show the consumption of lumber by the wood-manufacturing industries by States, industries, and species. Lumber prices form part of a continuous record maintained since 1908. Those secured in cooperation with the forest districts are essential in the appraisal of national-forest stumpage. Compilation of stumpage values is of economic importance in showing the general trend of timber values. Cooperation with the Forest-Products Laboratory at Madison aided in the formulation of a scientific grading rule for yellow-pine structural timber. A utilization study of blight-killed chestnut, in cooperation with the Bureau of Plant Industry and with States, demonstrated the merchantability of sound dead chestnut and the most profitable methods of utilization, located markets, and resulted in salvaging considerable dead chestnut. Thirty-four State wood-using industries reports have been published in cooperation with State officials. Hickory-handle specifications prepared by the Forest Service have been adopted by the Panama Canal Commission and the Navy and War Departments. Cooperation with Government departments included the inspection of lumber, navy yards, etc., and the revision of specifications.

Assignment.—H. S. Betts.

Proposed expenditures, 1916-17.—\$22,820.

Forest-Products Laboratory Supervision:

Object.—Administration and supervision of experimental investigations into the use, handling, and preservation of forest-grown products, conducted from the Forest-Products Laboratory.

Cooperation.—Bureau of Plant Industry, University of Wisconsin, University of Washington, and various engineering, chemical, and lumber associations, societies, and companies.

Location.—Madison, Wis., with branch at Seattle, Wash.

Date begun.—1902. (Laboratory at Madison in 1910.)

Assignment.—H. F. Weiss, C. P. Winslow.

Proposed expenditures, 1916-17.—\$8,080.

Timber Physics:

Object.—To secure information (1) on structure which will permit the classification or identification of woods, (2) on the relation of structural to the fundamental physical or mechanical properties, (3) on the relation of structure to drying and uses, and (4) on the fundamental physical properties, including changes under changing conditions in their relation to drying and all practical uses.

Procedure.—The work involves exhaustive studies of the structure of woods by the use of the microscope and photomicrographs, of the physical properties of wood, and of the effect on properties of conditioning or treating under high pressures, temperature, etc.; also intensive experiments with semicommercial apparatus on methods of kiln-drying and practical demonstrations in commercial plants of promising results.

Cooperation.—University of Wisconsin, various lumber manufacturers, etc.

Location.—Madison, Wis.

Date begun.—1903.

Results.—(1) During 1916 additional data were secured on fundamental physical properties. A method was developed for the satisfactory kiln-drying of maple, green from the saw, and satisfactory progress made along similar lines with California redwood, gum, and southern pine. Further developments were accomplished in methods of satisfactorily kiln-drying western larch. Some results of the studies on identification of woods were embodied in a manuscript for publication for the use of tie inspectors.

(2) Prior to 1916: A type of dry kiln has been designed and processes developed which show much greater efficiency than in average industrial practice. Six commercial concerns have installed dry kilns along the lines of these developments. Kiln-drying experiments have been conducted on a large number of different woods, including especially western larch. Over 1,100 samples of wood are annually identified and the information furnished to the public. The relation of moisture to the mechanical properties of wood was developed.

Assignment.—H. D. Tiemann, E. Gerry.

Proposed expenditures, 1916-17.—\$22,660.

Timber Tests:

Object.—To secure reliable data on the mechanical properties of various species and forms of timber for the use of foresters, engineers, manufacturers, and other users of wood, making possible the development of grading rules and specifications on a scientific basis and permitting the most advantageous use of various species and forms.

Procedure.—The work involves exhaustive tests of the mechanical and physical properties of small clear specimens of woods of different species and similar tests of timbers of structural sizes, both of which are preliminary to the development of grading rules; and to some extent tests with special forms of material, such as packing boxes, barrels, shipping containers, etc.

Cooperation.—University of Wisconsin and University of Washington.

Location.—Madison, Wis., and Seattle, Wash.

Date begun.—St. Louis, 1890; Madison, 1909.

Results.—(1) During 1916 grading rules developed for southern-pine structural timbers were adopted by the Southern Pine Association, American Society for Testing Materials, and the National Board of Fire Underwriters. Tentative grading rules for Douglas-fir structural timbers were developed. Tests on structural timbers of hemlock were completed as a preliminary step in the preparation of grading rules. A study of specifications and design for packing boxes and shipping containers was conducted and a method developed for comparing the efficiency of different types of containers for canned goods. Approximately 20,000 tests were made on small specimens to secure information on the mechanical properties of various species.

(2) Prior to 1916: Approximately 109,000 tests have been completed on over 100 American species. Grading rules formulated by the American Railway Engineering Association and also those of the American Society for Testing Materials have been largely based on Forest Service tests. Tests on hickory have resulted in a modification of specifications by the National Association of Hickory Manufacturers and by the Navy Department to permit the use of both red and white hickory. Tests of tapped and untapped southern pine have shown that tapping has no effect on strength. Tests on California tanbark oak have shown it to be suitable for many purposes for which eastern oak is used. Tests with shortleaf pine and white-cedar cross arms have shown these species to compare favorably with Douglas fir and longleaf pine. Steaming timber before preservative treatment has been shown frequently to reduce strength, and this method has been very largely discontinued or modified.

Timber Tests—Continued.

Investigations to improve the design and methods of construction of containers were inaugurated to reduce the present annual loss to railroads of approximately \$40,000,000 for goods lost or damaged in transit.

Assignment.—J. A. Newlin and T. R. C. Wilson, at Madison, Wis.; C. W. Zimmerman, at Seattle, Wash.

Proposed expenditures, 1916-17.—\$24,000.

Wood Preservation:

Object.—To secure data which will serve to promote the protection and preservation of wood from destruction by decay, fire, abrasion, or marine borers.

Procedure.—The work involves the determination of the physical and chemical properties of preservatives and fire retardants, intensive studies of the processes and relative ease with which preservatives may be injected into different species, pathological studies to determine the relative resistance of treated and untreated woods to decay, and the relative toxicity of various preservatives; intensive studies to develop cheap and highly toxic preservatives and cheap and effective fire retardants; laboratory tests to determine the comparative efficacy of fire retardants; technical investigations with semicommercial apparatus of the most efficient methods of treating with various preservative woods of different kinds and forms; and tests with timbers, ties, poles, paving blocks, mining timbers, piling, etc., to determine under actual service conditions the life of various species differently treated for various uses in different regions.

Cooperation.—University of Wisconsin.

Location.—Madison, Wis.

Date begun.—1903.

Results.—(1) During 1916: Tests were completed and a manuscript for publication prepared on the relative ease of treatment of a large number of American hardwoods. Intensive studies of methods of treating Douglas fir without causing a loss in strength have been conducted and methods developed which indicate a great improvement over former practice. Tests on fire retardants have been continued and valuable information secured on the effect of different fire conditions on material untreated and treated with various commercial fire retardants. Extensive tests have partially demonstrated the value of sodium fluoride as a successful preventive of sap stain in lumber. Methods of treating paving blocks have been developed and formed the basis of tentative specifications now under consideration by the American Wood Preservers' Association and the American Society for Municipal Improvements. A manuscript has been prepared for publication covering an intensive study of physical and mechanical properties of a large number of authentic samples of coal-tar and water-gas-tar creosotes. Tests have indicated the value of creosoted timber for silo construction.

(2) Prior to 1916: Tests on over 30 commercial wood preservatives were completed, including an intensive study of the physical and chemical properties of various types of creosotes. Comparative studies on the relative ease of treatment of conifers were completed and similar studies on hardwoods undertaken. Many data were secured on the effect of variables in treatments on the efficiency of the process. During 1914 special attention was devoted to methods of rendering wood fire retardant. Tests to compare the life of treated and untreated material under actual service conditions were inaugurated in cooperation with railroad companies, municipalities, telephone companies, mine companies, etc. Forty-two sets of test material in various parts of the country are inspected at regular intervals. It has been shown from these experiments that the life of wood in exposed situations may in general be increased at least three times by proper preservative treatment and that many woods of comparatively little natural value for railroad ties, such as loblolly pine, jack pine, lodgepole pine, etc., can be treated readily and made suitable. The use of such materials for ties has doubled within the last five years. Results of studies of paving-block treatment have been largely utilized by Chicago and other municipalities in specifications. Intensive studies have been conducted on the methods of analysis, etc., of wood preservatives. The specifications of the American Railway Engineering Association and the National Electric Light Association are largely based on this work. Methods of treating poles and posts by the brush and open-tank processes have been investigated, and the specifications adopted by the National Electric Light Association are based on the results.

Assignment.—C. H. Teesdale, G. M. Hunt.

Proposed expenditures, 1916-17.—\$20,960.

Wood Distillation and Derived Products:

Object.—To secure data on the chemical composition and chemical properties of wood; on the suitability of different woods, wood waste, and other forest-grown material for derived products, including those of wood distillation, the naval-stores industry, grain alcohol from sawdust, producer gas from wood waste, etc.; and on the most efficient methods of producing and refining these derived products and their chemical composites and uses.

Procedure.—Methods are being developed for the chemical analyses of woods in wood distillation, production of ethyl alcohol, etc. Technological studies are conducted on a semicommercial basis to determine the effect of the fundamental variables on the efficiency of the process and to determine the suitability of different forms and species of woods. In the naval-stores work, in addition to distillation studies, field investigations of extraction and yields from different species under varying methods are conducted, chemical analyses of products are made, refining processes studied, and efforts made to develop uses, and commercial demonstrations are made of promising results.

Cooperation.—University of Wisconsin and various engineering, chemical, and lumber associations, societies, and companies.

Location.—Madison, Wis.

Date begun.—1907.

Results.—(1) During 1916: Further commercial demonstration of methods for increasing the yield of valuable products in the destructive distillation of hardwoods has been satisfactorily carried out. Tests to determine the suitability of several different species, including western larch, for the production of ethyl alcohol have been completed. Studies to determine the value of osage orange as a dye wood have resulted in the commercial utilization for this purpose of a considerable quantity of material formerly wasted. Methods were developed for purifying turpentine and pine oils recovered in the manufacture of sulphate pulp from resinous woods. A new type of turpentine hack for improving the efficiency of naval-stores operations was developed and is now under commercial test. Studies to determine the effect of two years turpentine on the value of the lumber show a loss too small to be of significance.

(2) Prior to 1916: In the destructive distillation of hardwoods an improved method greatly increased the yield of alcohol and acetate of lime. These methods were partially demonstrated on a commercial scale. Tests have shown that commercial yields of acetate of lime and wood alcohol can be obtained from hickory, oak, tupelo, and red gum. The results of investigations with wood turpentine have been used in formulating specifications adopted by the American Chemical Society, the American Society for Testing Materials, the Navy Department, and the Isthmian Canal Commission. Progress was made in determining the effect of some of the fundamental variables involved in the production of ethyl alcohol from wood waste. Tests were completed on the quantity and character of oils which may be secured from leaves and twigs of conifers, and these oils are under commercial test to determine their usefulness. Field experiments comparing improved methods of cupping with the boxing in common industrial use showed marked improvement for the new method in yield of gum and in reducing deterioration of lumber. These improved methods of turpentine have been largely adopted in the trade. Experiments in Arizona, California, and Colorado showed yields of turpentine and rosin from western yellow pine sufficiently great to make this species a possible future source of naval stores.

Assignment.—S. F. Acree, E. Bateman, A. W. Schorger, F. W. Kressman.

Proposed expenditures, 1916-17.—\$27,140.

Pulp and Paper Investigations:

Object.—To secure information on the suitability of different woods for pulp under various methods of manufacture; to increase the efficiency of the various established industrial processes and develop new and improved processes.

Procedure.—The work involves technological experiments on semicommercial apparatus, together with detailed chemical analyses and microscopic studies of wood structure, pulp fibers, etc. Promising results are demonstrated on a commercial scale.

Cooperation.—University of Wisconsin.

Location.—Madison, Wis.

Date begun.—1905.

Results.—(1) During 1916: A new sulphate method was developed which in laboratory tests increases both yield and quality and which is especially applicable for the production of wrapping paper from southern pine. It is hoped during the coming year to demonstrate its value commercially. A method

Pulp and Paper Investigations—Continued.

was developed for the utilization of bark previously wasted or having only a small fuel value. Other possibilities for the utilization of bark in certain grades of wall paper are under investigation. A method was developed for the recovery of turpentine and rosin from woods while cooking by the sulphate process, and a commercial application of this new development is anticipated.

(2) Prior to 1916: Tests showed that pulps suitable for commercial use as news and wrapping paper can be made by the sulphite process from eight species of native woods, several of which grow in large quantities on the national forests, some of them being now used to a limited extent and others not at all. Other species are under investigation. Tests have shown that three native species—jack pine, tamarack, and hemlock—of which large quantities are available in the Lake States, can be satisfactorily substituted for spruce in the ground-wood process in making the cheaper grades of paper, such as news and wrappings. Several mills have begun grinding these woods. A number of western woods were also tested. Tests have shown that pulps suitable for book or wrapping paper can be made from 12 new species of native woods by the soda process. Several other native species show commercial possibilities as soda pulp woods. Tests showed that the highest grades of "kraft" paper can be made from longleaf pine by the soda and sulphate processes. A number of methods of increasing the yield of pulp from the raw material without decreasing the quality of the product have been found. Tests by the sulphate process, now little used in the United States, have shown especial possibilities as a means of making paper from mill waste.

Assignment.—O. Kress, S. D. Wells.

Proposed expenditures, 1916-17.—\$26,420.

Lumber Industry Studies:

Object.—To secure authoritative information on the underlying causes of the present unsatisfactory conditions in the lumber industry, so that the Government may be in a position to deal constructively and helpfully with the situation, both from the standpoint of the public and the industry; to secure valuable data on methods and costs of logging and lumber manufacture and the equipment employed, as a basis for stumpage appraisals and the development of proper relations between lumbering and forestry; to secure special information by mill-scale and depreciation studies in regard to yield and quality of lumber from different grades, sizes, and species of logs in different sections of the country, also the depreciation in value of lumber from the time it is cut until shipped, particularly for use in connection with appraisals of Forest Service stumpage; to secure information on waste in connection with logging and milling operations.

Procedure.—Special investigators confer with leading men in the industry and visit carefully selected producing operations or distributing concerns, making field studies of operations or critical reviews and analyses of records, or both. The economic phase of this study will be extended to regions not yet covered. In the case of mill-scale and lumber depreciation studies detailed grading and other records of the logs and mill products are made. A number of additional studies of this character will be made for new species and regions. Exact data on waste will be secured for various species in the woods and at the mill.

Cooperation.—Federal Trade Commission, in the economic study; various associations and lumber companies, in methods and costs and mill-scale depreciation and waste studies.

Location.—Washington, D. C., Madison, Wis., district offices, and national forests; also particular lumber producing and distributing regions outside of national-forest regions.

Date begun.—Mill scale and depreciation studies, 1903; costs and methods studies, 1912; economic study, 1914.

Results.—(1) During 1916: In the economic study, a series of 10 reports covering production in four regions, lumber distribution, uses of the public timber, substitutes for wood, low grades, and waste, and grade adaptations were practically completed. In methods and costs study a report on logging in California was completed. In mill-scale and depreciation studies, a number of studies for individual species and regions was completed.

(2) Prior to 1916: A large amount of data has been collected in the economic study and also for many regions of the United States on lumbering methods and costs and in mill-scale depreciation and waste studies.

Assignment.—W. B. Greeley, Earle H. Clapp, H. F. Weiss, H. S. Betts, H. N. Knowlton, H. B. Oakleaf, C. S. Smith.

Proposed expenditures, 1916-17.—\$4,460.

Total, Forest-Products Investigations, \$178,100, including \$42,900 statutory.

[Research.]

RANGE INVESTIGATIONS.

Supervision, Inspection, and General Investigations:

Object.—Office supervision, field inspection and supervision of all work connected with range investigations carried on by the Forest Service, and collection of data of a general character during the course of field inspection.

Cooperation.—Office of Economic and Systematic Botany, Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1907.

Assignment.—J. T. Jardine, A. E. Aldous.

Proposed expenditures, 1916-17.—\$4,460.

Artificial Reseeding:

Object.—To determine (1) the lands where seeding to cultivated species of forage plants is economically possible from the range standpoint, as determined by altitude, exposure, soil, moisture, competition with native vegetation, and cost; (2) the species best adapted to any given set of conditions; (3) the best time to sow and the cultural methods which should be adopted; (4) the necessary protection against grazing; and (5) the possibility of growing promising native species under cultivation and securing seed of such species for use in range reseeded.

Procedure.—Major investigations are conducted on small areas in a few localities by investigators especially qualified and equipped to make the careful study of all factors important in determining success or failure of a given species for range seeding. These intensive studies have been supplemented by over 500 seeding tests, which were outlined by the special investigators but carried out in large part by members of local forest forces. The object of the supplemental tests is to demonstrate principles developed by the intensive studies and to make the conclusions of the intensive studies more comprehensive by including a larger territory than is possible if the investigations in all cases involve a study in detail of the specific reasons for success or failure. The investigations during the coming year will be confined to thorough study on a small scale at experiment stations where men especially qualified for the intensive studies are located.

Cooperation.—Office of Economic and Systematic Botany, Bureau of Plant Industry, and S. T. Turney, Las Cruces, N. Mex.

Location.—Manti Forest, Utah, Coconino Forest, Ariz., and Jornada Range Reserve, Dona Ana County, N. Mex.

Date begun.—1907.

Results.—(1) Results secured during 1916 confirmed the conclusions of previous work that seeding range lands to cultivated species is practicable only on a comparatively small proportion of these lands, and furnished further data of value in selecting the areas where seeding may be advisable.

(2) Investigations prior to 1912 indicated that (a) seeding range lands to cultivated species is economically possible only on mountain meadows and other areas of minor extent having favorable soil and moisture conditions and below 500 feet of the true timber line; (b) late fall seeding and planting the seed by harrowing or trampling with sheep or by other means are advisable; (c) protection against grazing is essential the first year after seeding. The results on which these and other conclusions were based were published in Department Bulletin 4. The results of investigations since 1912 indicate that it will be difficult and, if finally feasible, will require considerable time to place promising native forage plants under cultivation in order to secure seed at a cost not prohibitive to distribution in reseeded depleted ranges where the present cultivated species will not make a successful growth.

Assignment.—A. W. Sampson, G. A. Pearson, L. C. Hurtt.

Proposed expenditures, 1916-17.—\$1,100.

Natural Reseeding:

Object.—To develop plans of range management which will secure natural reseeded of range lands with a minimum loss of forage through nonuse.

Procedure.—In studying this problem the first step is to determine for the principal range plants making up the forage crop the time growth begins and ends, the time of flowering, time of seed maturity, amount of seed produced, germination of seed, and other facts influencing the power of the plants to reproduce them-

Natural Reseeding—Continued.

selves naturally under range conditions. With these data available a comparative study is made of reproduction under total protection from grazing, grazing after seed maturity, and the existing grazing practice, with a view to work out a system of grazing which will allow the use of all forage each year and at the same time keep the forage plants vigorous and occasionally allow the production of a seed crop. The quadrat or plat method of study supplemented by general observations is followed, in order to ascertain any change in composition, density, or vigor of the vegetation. This method will be followed in the proposed studies with the view of working out efficient grazing practice for overgrazed lands at high altitudes in Utah forests, for the purpose of demonstrating the advantages of "deferred and rotation" grazing on the Eldorado and Medicine Bow Forests, and for the purpose of developing a plan of grazing for the dry ranges of the Southwest.

Cooperation.—Office of Economic and Systematic Botany, Bureau of Plant Industry, and S. T. Turney, Las Cruces, N. Mex.

Location.—Utah Experiment Station on the Manti National Forest, Utah, Eldorado National Forest, Cal., Medicine Bow National Forest, Wyo., Jornada Grazing Reserve, N. Mex., and Santa Rita Grazing Reserve, Ariz.

Date begun.—1907.

Results.—(1) During 1916: Observations during the past year confirmed the conclusions from previous work that partly depleted western range lands can be improved and the stand of vegetation maintained without loss of forage through nonuse by adopting a system of "deferred and rotation" grazing. This system was extended to additional lands during the year.

(2) Prior to 1916: As a result of the studies in natural reseeded, the system of "deferred and rotation" grazing now being put into application on national-forest ranges has been worked out. The principles upon which this system is based are fundamental, and it remains to adapt them to local conditions. The results in full were published in Department Bulletin 34, and in the Journal of Agricultural Research of November 16, 1914. Short articles have been published in outside journals.

Probable date of completion.—The experiments under way at present in Utah, California, and Wyoming will be completed probably in 1918. The proposed studies in the Southwest will necessarily continue not less than five years.

Assignment.—A. W. Sampson, L. H. Douglas, L. C. Hurtt, R. L. Hensel.

Proposed expenditures, 1916-17.—\$3,500.

Distribution and Economic Importance of Herbaceous and Shrubby Plants on National-Forest Ranges:

Object.—The collection and identification of herbaceous and shrubby plants on national-forest ranges and the accumulation of notes on distribution, growth requirements, forage value, and objectionable qualities, to serve as a basis for (1) allotment of range to the class of stock for which it is best adapted, (2) proper adjustment of seasons of grazing, (3) determination of the carrying capacity of the range, (4) adjusting management to eliminate or decrease the loss of stock from stock-poisoning plants, (5) application of "deferred and rotation" grazing, and (6) general application of results from specific investigations. The most efficient management of range lands necessitates a thorough knowledge of the vegetation which makes up the forage crop.

Procedure.—All members of the grazing investigative force make collections of plants and observations relative to their life history, natural requirements, and forage value in connection with the work of other projects. In addition, local forest officers collect and submit specimens to secure identification and forage value of each plant submitted. All plants are identified by the department, and notes are assembled and disseminated by members of the grazing investigative force of the Forest Service. This plan will be continued, and the data as rapidly as available will be disseminated among local forest officers and through them to stockmen by reporting on plant collections submitted for identification.

Cooperation.—Office of Economic and Systematic Botany, Bureau of Plant Industry.

Location.—Collection of specimens and notes, on all national forests; identification of specimens and assembling of notes, at Washington, D. C.

Date begun.—1911.

Results.—(1) During 1916: Approximately 4,500 specimens, including several new species, were collected during the year and notes furnished the collectors.

Additional economic notes were collected in the field and compiled.

Distribution and Economic Importance of Herbaceous and Shrubby Plants on National-Forest Ranges—Continued.

(2) Prior to 1916: Approximately 23,000 specimens were collected and identified and notes on approximately 2,000 species returned to collectors. The result is the gradual education of forest officers and stockmen as to the identification, requirements, and value of the herbaceous and shrubby plants which make up the forage crop on approximately 100,000,000 acres of lands used for grazing within the national forests, with a consequent improvement in the management of the grazing on these lands.

Assignment.—W. A. Dayton.

Proposed expenditures, 1916-17.—\$4,000.

Grazing in Relation to Tree Reproduction, Erosion, and Stream Flow:

Object.—To determine the effect of grazing upon tree reproduction, erosion, and stream flow, and to work out methods of handling stock so as to minimize or eliminate unwarranted injury due to grazing.

Procedure.—The effect of grazing upon tree reproduction and the extent to which injury can be decreased by changes in grazing management and methods of handling stock in localities which are typical of large regions are studied. Special areas are then selected on cattle range, sheep range, and goat range to represent various conditions of slope, soil, vegetation, and different tree species. Numerous small plats are located, definitely marked, and all tree growth examined from two to four times during the year for a period of three to five years, depending upon species under consideration, class of stock, and range conditions. Fenced areas are always provided to permit a comparative study of reproduction and vigor of reproduction under protection against grazing and under the existing systems of grazing. The extent of injury from grazing by different classes of stock during the various seasons of grazing, under different methods of handling, and on the various range types is thus determined. With these data as a basis, a system of grazing management which will allow the maximum use of range consistent with permissible damage to forest growth, is worked out. The major field work in the study of sheep and cattle grazing on conifer timber lands was completed at the end of the past field season. Reexamination of all plats every three years for a period of 10 to 15 years is proposed. A study of sheep and cattle grazing on aspen lands is well under way and will be continued. A study of goat grazing was started during the field season of 1915. Grazing as a factor in causing erosion and floods from the high mountain lands is the major problem of the Utah Experiment Station. Two areas comparable in every way are under comparative study—one under grazing and the other totally protected against grazing. All "run off," both water and sediment, is measured accurately, and all necessary meteorological data are collected throughout the year. The plan contemplates having the factor of grazing the only variable one in the comparative study, the other factors being either the same or in a definite constant relation for the two areas. This plan will be continued throughout the period of study. The intensive study will be supplemented by general observations throughout the national forests.

Cooperation.—Office of Economic and Systematic Botany, Bureau of Plant Industry.

Location.—Coconino Forest, Ariz., Shasta Forest, Cal., Payette Forest, Idaho, Manti Forest, Utah, and Alamo and Gila Forests, N. Mex., for specific studies; general observations throughout the national forests.

Date begun.—1911.

Results.—(1) During 1916: Valuable data relative to management of goats on ranges within the national forests of the Southwest were collected and suggestions for changes in management furnished to local forest officers. As in the case of previous studies with other classes of stock, it was found that damage from goat grazing can be materially reduced by improved methods of handling the goats on the range.

(2) Prior to 1916: Major field work was completed in the study of sheep and cattle grazing on conifer timberlands, and suggestions for changes in management of range and stock have been furnished to local forest officers. It has been found that, by care in placing cattle and sheep on range best adapted to each class of stock and by following the "open-herding bedding-out" system of handling sheep, much of the damage done in the past to tree reproduction, forage crops, and in starting erosion can be avoided. Suggested improvements are being put into practice in national-forest administration.

Assignment.—A. W. Sampson, R. R. Hill, W. A. Dayton, W. R. Chapline.

Proposed expenditures, 1916-17.—\$6,600.

Methods of Handling Stock under Range Conditions:

Object.—To reduce to a minimum the waste of forage in utilizing the range and to minimize the cost of efficient handling both to stock owners and to the Forest Service. The work involves studies to determine the most satisfactory size of band, method of herding, salting, watering, and lambing in the case of sheep; and, for cattle, methods of control and handling throughout the grazing period.

Procedure.—The investigations on this project were begun with a band of sheep on a typical mountain summer sheep range placed under coyote-proof fence. A comparative study of handling under fence and handling under the old system of herding on open range was conducted through a period of four years to learn the natural habits of sheep under fence, the necessary restrictions in order to herd sheep successfully without fences on different kinds of range, and possible advantageous changes in existing methods of handling. These studies resulted in the "open-herding bedding-out" system of herding sheep. Studies since 1911 have aimed at working out variations in this system for different localities and at the same time have served to demonstrate the advantages of the new over the old system. All studies are made under practical range conditions and are always a comparative study of the existing systems and the methods proposed, in order that results will be conclusive both as to practical application and advantages of the new methods. The problem of range lambing has been attacked in the same way. Studies and demonstration tests along these lines are contemplated until all sheep on national-forest ranges are handled under the improved methods. In 1912 similar studies were started on a small scale with cattle. These studies have been materially broadened and made more comprehensive as regards different methods of handling and the advantages and disadvantages of each method, both to stock and range, by the investigations started during the summer of 1915 on the Jornada and Santa Rita Grazing Reserves in the Southwest.

Cooperation.—Office of Economic and Systematic Botany, Bureau of Plant Industry, and S. T. Turney, Las Cruces, N. Mex.

Location.—Absaroka, Beartooth, and Helena Forests, Mont., Gunnison and Cochetopa Forests, Colo., Medicine Bow Forest, Wyo., Caribou, Manti, Fillmore, Fishlake, and Sevier Forests, Utah, Inyo and Lassen Forests, Cal., Datil Forest and Jornada Grazing Reserve, N. Mex., and Santa Rita Grazing Reserve, Ariz.

Date begun.—1907.

Results.—(1) During 1916: Observations and results during the past year confirmed those of previous years relative to improved methods of handling both sheep and cattle, and improved methods were adopted in a number of localities where they had not previously been followed. Sentiment in favor of improved methods was greatly strengthened.

(2) Prior to 1916: The "open-herding bedding-out" system of herding sheep was developed and put into operation on approximately 50 per cent of the sheep ranges within the national forests, with a resultant increase of 10 per cent in carrying capacity and 5 pounds increase in weight of lambs where the new system is followed. Improved methods of handling sheep under range conditions during the lambing season have proved efficient under practical application by sheep owners. Information of value has been obtained relative to drift and division fences to control cattle on national-forest ranges. Data on these subjects have been published in Forest Service Circulars 156, 160, and 178, Forest Service Bulletin 97, and a number of papers in outside journals, especially a series of six papers in the National Wool Grower, beginning with the March, 1915, issue.

Assignment.—J. T. Jardine, F. D. Douthitt, L. C. Hurtt, R. L. Hensel, L. H. Douglas, R. R. Hill, Mark Anderson.

Proposed expenditures, 1916-17.—\$7,800.

Distribution and Development of Stock-Watering Places:

Object.—To determine the distribution of stock-watering places necessary for different classes of stock under various conditions of topography and forage, in order to properly utilize the range; and to collect data as to the best methods of developing stock-watering places under conditions existing throughout the western ranges.

Procedure.—Observations were made in 1913 on 700 watering places developed on national-forest ranges prior to that date, with a view to ascertain the methods most satisfactory for a given set of local conditions and for the purpose of securing data relative to proper distribution of water under given conditions of topography, range, and class of stock. The conclusions were published in Farmers' Bulletin 592. Observations are being continued on projects developed

Distribution and Development of Stock-Watering Places—Continued.

prior to and since 1912. No special experiments are being conducted. In connection with the investigations conducted at the Jornada and Santa Rita Grazing Reserves in the Southwest, special study is being made to determine proper distribution of watering places as well as cost and methods of developing water on the semidesert ranges of the Southwest.

Cooperation.—Office of Economic and Systematic Botany, Bureau of Plant Industry, and S. T. Turney, Las Cruces, N. Mex.

Location.—Jornada and Santa Rita Grazing Reserves and national forests.

Date begun.—1913.

Results.—(1) During 1916: Observations show that on the semidesert ranges of the Southwest watering places should not be more than approximately 3 miles apart to secure efficient use of the range. Observations throughout the national forests relative to the value of adequate well-distributed watering places aided materially in stimulating cooperation from stockmen in this line of improvement.

(2) Prior to 1916: Farmers' Bulletin 592 furnishes information as to the importance of properly distributed watering places to efficient range management and gives concise suggestions as to methods of developing and protecting watering places. The general result has been a more aggressive effort on the part of forest officers and stock owners to develop adequate water for the maximum production of stock on available range, and good progress has been made.

Assignment.—J. T. Jardine, L. C. Hurtt, R. L. Hensel.

Proposed expenditures, 1916-17.—\$400.

Eradication of Poisonous Plants:

Object.—After information is furnished by the Bureau of Animal Industry as to the species which are poisonous to stock, the class of stock to which each species is poisonous, and the state of growth at which it is poisonous, it is then necessary to learn the distribution of each species throughout the national forests and to work out methods of protecting stock against poisoning. The distribution is gradually being determined through the project "Distribution and Economic Importance of Herbaceous and Shrubby Plants on National-Forest Ranges." Loss of stock from poisoning is being gradually reduced by (1) locating and posting poisonous-plant areas with warnings, (2) fencing poisonous-plant areas to hold stock off until they can safely graze the areas in question, (3) grazing larkspur areas within cattle range by sheep before the cattle are put on the range, (4) eradicating the poisonous plants, and (5) more careful handling of the stock, such as by following the "bedding-out" system of herding sheep, which avoids much loss resulting from improper handling. The object of the investigations under this project is to find out the most efficient methods of eradicating the poisonous plants, the conditions under which eradication is practicable, the conditions under which it is practicable to use sheep in removing larkspur annually from cattle ranges, and the conditions under which the cost of constructing drift or pasture fences as a protection against loss from poison is feasible, and to ascertain the extent to which poisonous-plant areas can safely be grazed if improved methods of handling are followed.

Procedure.—Actual eradication by cutting at different stages of growth and by digging up the plants are made under range conditions. Actual tests of grazing larkspur areas throughout the cattle range by sheep are being made. Many fences have been constructed, and the results in the way of eliminating loss are being observed. In all cases record is kept to determine the cost of preventive measures adopted as compared with the value of live stock saved from poisoning. It is planned during the coming year to follow up the practical test of eradicating larkspur from one range on the Stanislaus Forest in California, begun in 1915, to continue the sheep-grazing tests on the Ruby and Mono Forests in Nevada, to continue experiments on methods of eradication at the Utah Experiment Station, and to start tests in eradication of loco elsewhere.

Cooperation.—Office of Economic and Systematic Botany, Bureau of Plant Industry; Pathological Division, Bureau of Animal Industry; and stockmen on the national forests.

Location.—Stanislaus Forest, Cal., Humboldt, Mona, and Ruby Forests, Nev., Manti and Fishlake Forests, Utah, Pike Forest, Colo., and Madison Forest, Mont.

Date begun.—1912.

Results.—(1) During 1916: A practical test of eradicating larkspur by digging it up was made in cooperation with cattlemen on a cattle range of about 14,000 acres within the Stanislaus Forest, Cal. The range contained approximately 67 acres of larkspur, which was dug out at a cost of \$695 for labor. The average

Eradication of Poisonous Plants—Continued.

loss of cattle from poisoning on this range in previous years was 34 head; the loss in 1915 was reduced to four head. The result is a striking example of what can be done where conditions are similar to those on the Stanislaus Forest.

(2) Prior to 1916: It was shown that under certain conditions eradication of tall larkspur by grubbing out the plants is practicable; that loss of cattle from larkspur poisoning can be eliminated where the larkspur patches can be grazed off by sheep before the cattle are put on the range; that loss of sheep can be decreased by following the "bedding-out" system of herding, and that construction of drift fences is a matter of economy under many conditions.

Assignment.—J. T. Jardine, A. E. Aldous, A. W. Sampson.

Proposed expenditures, 1916-17.—\$2,600.

(Checking Erosion in Mountain Meadows: Project completed. Thorough examination was made during the past year of experimental tests with dams previously constructed, and suggestions have been prepared for local forest officers relative to management in order to guard against further erosion in its early stages. Advanced cases of meadow erosion can be checked and damage repaired only by expensive engineering construction.)

Climatic Characteristics of Vegetative Belts on the Manti Forest:

Object.—To obtain and correlate exact measurements of climatic factors which limit the distribution of species and bring about distinct plant formations or vegetative types locally on the Manti Forest.

Procedure.—It is proposed to make observations in the oak, aspen, and Engelmann spruce associations at 7,000 feet, 8,700 feet, and 10,000 feet, respectively, under similar conditions of slope and exposure. The following factors will be recorded throughout the season: Air temperatures by thermographs; soil temperatures, 6, 12, and 24 inches deep, read at 8 a. m. and 6 p. m.; soil moisture, 10-day periods, at 6, 12, and 24 inch depths; evaporation by means of the Livingston porous-cup atmometer and by exposure of free-water surface; precipitation throughout the year with tipping bucket and standard rain gauges and by snow-scale measurements and water-content determinations of snow.

Cooperation.—Weather Bureau and Office of Economic and Systematic Botany, Bureau of Plant Industry.

Location.—Utah Experiment Station, Manti Forest, Utah.

Date begun.—1913.

Results.—(1) During 1916: Records of all factors have been secured to date. For every increase of 1,000 feet in altitude the time at which growth begins is found to be later by approximately 10 days.

(2) Prior to 1916: Observation stations were selected, equipment installed, and records of all factors secured for approximately one year.

Assignment.—A. W. Sampson.

Proposed expenditures, 1916-17.—\$500.

Total, Range Investigations, \$30,960, including \$960 statutory.

[Regulation.]

PLANTING NATIONAL FORESTS.**Reforestation:**

Object.—To reforest national-forest areas entirely denuded or scantily covered with forest growth; also to secure seed and to maintain nurseries for the production of planting stock.

Procedure.—The work is planned and conducted on the basis of restocking annually approximately 14,000 acres by planting and 2,500 acres by direct seeding. Permanent Forest Service nurseries produce the required amount of stock for planting. Native seed is collected from the national forests, and exotic seed, of which but a small supply is used for planting stock in the nurseries, is purchased.

Location.—Washington, D. C., district offices, and national forests.

Date begun.—1901.

Results.—During the fiscal year 1915, 5,876.15 acres of national-forest land were sown to tree seed and 9,731.76 acres were planted.

Assignment.—W. B. Greeley, district foresters, and forest supervisors.

Proposed expenditures, 1916-17.—\$156,750, including \$660 statutory. (\$9,550 of the appropriation for planting national forests is allotted to the project "Forestation Studies," described under "Silvicultural Investigations.")

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[Research.]

SILVICULTURAL INVESTIGATIONS.**Dendrological Studies:**

Object.—(1) To bring together in a comprehensive manner all the available information on common names, geographical distribution, botanical characteristics, occurrence, and habits of forest trees by groups or genera; (2) to secure new information concerning the distinguishing characteristics and geographical distribution of North American trees and shrubs.

Procedure.—New data are secured through collections of local forest officers, examination of the various herbaria in the United States, and by the actual field work of the men directly charged with the dendrological studies. During 1917 it is planned to issue publications on the conifers of the Rocky Mountain region not covered by bulletins already issued, and possibly on certain of the hardwoods of the region.

Cooperation.—National Herbarium.

Location.—Washington, D. C.

Date begun.—1886.

Results.—(1) During the fiscal year 1916 Department Bulletins 207, "The Cypress and Juniper Trees of the Rocky Mountain Region," and 327, "The Spruce and Balsam Fir Trees of the Rocky Mountain Region," were published; 157 maps of tree species and 4 regional maps were prepared for publication; some 800 new range notes were added to the records; studies of the genus *Ceanothus* were continued with special reference to the distribution of species in California; and about 500 dendrological identifications were made.

(2) Previous to 1916: Range maps were prepared for practically all important tree species native to the United States. These were published, as well as an atlas on the pines and an unnumbered bulletin on the "Forest Trees of the Pacific Slope."

Assignment.—George B. Sudworth, W. H. Lamb, Georgia E. Wharton.

Proposed expenditures, 1916-17.—\$8,450.

Forestation Studies:**(a) SEED STUDIES—**

Object.—To determine the best methods of seed extraction, comparative germination of seed in greenhouse and field, seed production, and the effect of source of seed upon the resulting stock, for most of the important timber trees of the western national forests.

Procedure.—Samples of seeds collected on the various national forests are tested in the greenhouses of the experiment stations to determine their germinability, and at several of the stations seed are also directly extracted from the cones, and the temperature most favorable for the rapid opening of the cones without injury to the viability of the seed is determined. Studies of the effect of source of seed upon the resulting stock are conducted by means of sample plats. Much of the work during the present year will be devoted to the study of the seed of western white pine, Engelmann spruce, and Douglas fir. Twelve experiments are now under way.

Location.—Forest experiment stations and nurseries on the national forests.

Date begun.—1910.

Results.—During the fiscal year 1916 much new information was secured on the best methods of seed extraction and on the importance of source of seed, particularly in the case of lodgepole pine, western yellow pine, and Douglas fir. As a result of previous work a fund of useful information is now available regarding the characteristics and behavior of the seed of all of the important western species.

Probable date of completion.—Many of the studies will be completed by 1918.

Assignment.—D. R. Brewster, C. G. Bates, G. A. Pearson, J. A. Mitchell, J. V. Hofmann.

Proposed expenditures, 1916-17.—\$5,590.

(b) NURSERY PRACTICE—

Object.—To determine the best amount of seed to sow, time of sowing, depth of covering seed, methods of sowing, fertilizing, shading, watering, cultivation, and root development, time and method of transplanting, and methods of retarding spring growth in nursery stock, with the principal timber trees on the western national forests.

Procedure.—Small experiments are conducted at the nurseries of the experiment stations as well as at the large administrative nurseries, which have been established primarily for the raising of stock for planting on the national forests. Eighteen experiments are now under way.

Reforestation Studies—Continued.

Location.—All forest experiment stations and nurseries.

Date begun.—1910.

Results.—During the past year progress has been made upon all lines under investigation, particularly with reference to time of sowing, shading, and fertilizing, and a manual on nursery practice has been prepared. Previous experiments have resulted in the accumulation of sufficient detailed data to place the growing of nursery stock on a large scale on a solid basis.

Probable date of completion.—Many of the studies will be completed by 1918.

Assignment.—D. R. Brewster, C. G. Bates, G. A. Pearson, S. E. Bower, J. A. Mitchell, E. N. Munns, J. F. Kummel.

Proposed expenditures, 1916-17.—\$11,210.

(c) SOWING AND PLANTING STUDIES—

Object.—To determine the best season and methods for sowing and planting in the field, the classes of stock to use, and the sites most suitable to the different species, for most of the important timber trees on the western national forests.

Procedure.—Small sample plats are located at the experiment stations, and experiments are also conducted in connection with the large-scale reforestation operations of the national forests. Sixty-four studies are now under way.

Location.—Forest experiment stations on the national forests and a number of forests where reforestation work is conducted.

Date begun.—1910.

Results.—During the past fiscal year marked progress was made along all lines under investigation, particularly with reference to size and age of stock and season of sowing, and a manual on planting and sowing methods was prepared. Previous experiments have resulted in an improvement of the reforestation work on the national forests, both in the discarding of poor methods and in the development of good methods.

Probable date of completion.—Many of the studies will be completed by 1920.

Assignment.—D. R. Brewster, C. G. Bates, G. A. Pearson, S. E. Bower, E. N. Munns, J. A. Mitchell, J. F. Kummel.

Proposed expenditures, 1916-17.—\$11,210.

Studies of Forest Influences:

Object.—To determine the relation of forests to climate and stream flow, and also to obtain data necessary for a proper understanding of all silvicultural experiments in which the climatic factor enters into the results.

Procedure.—At the eight experiment stations meteorological observations are being carried on in various forest types. The results of these observations are correlated with those on forest cover. At the Wagon Wheel Gap station the relation of forest cover to stream flow is given the main attention. The problem is studied on two adjacent watersheds, one of which is to be denuded and the other left under forest cover. Five studies are now under way.

Cooperation.—Weather Bureau.

Location.—Forest experiment stations.

Date begun.—1910.

Results.—(1) During 1916: Much additional information was secured upon the climatic characteristics of the most important forest types in the national forests.

(2) Prior to 1916: Previous work has resulted in the accumulation of a large amount of data on the climatic characteristics of forest types and their influence on their environment. Two articles, "A Meteorological Study of Parks and Timbered Areas in the Western Yellow-Pine Forests of Arizona and New Mexico" and "Influences of a Western Yellow-Pine Forest on the Accumulation and Melting of Snow," were published in the Monthly Weather Review for October, 1913, and March, 1915.

Assignment.—D. R. Brewster, C. G. Bates, J. A. Mitchell, E. N. Munns.

Proposed expenditures, 1916-17.—\$3,000.

Forest-Management Studies:

Object.—To determine the best methods of cutting in different forest types in order to secure natural reproduction in the shortest possible time and to improve the quality and productivity of the stand.

Procedure.—In connection with the timber sales on the national forests sample plots are cut under different silvicultural methods and the effect on the natural reproduction studied. Studies are also made of reproduction on cut-over and burned-over land. Thirty-four studies are now under way.

Location.—Forest experiment stations and national forests.

Date begun.—1912.

Forest-Management Studies—Continued.

Results.—(1) During 1916: Particularly important discoveries were made regarding the natural reproduction of western white pine and Douglas fir. A publication on "The Northern Hardwood Forest; Its Composition, Growth, and Management," was issued as Department Bulletin 285.

(2) Prior to 1916: Previous work has resulted in the modification of methods of cutting timber on the national forests so as to insure natural reproduction following cutting.

Assignment.—Raphael Zon, D. R. Brewster, C. G. Bates, G. A. Pearson, J. A. Mitchell, J. V. Hofmann.

Proposed expenditures, 1916-17.—\$24,028.

Volume, Growth, and Yield Studies:

Object.—To secure reliable data as to the volume, growth, and yield of the different species and types of forests as a basis for the proper handling of timber sales, management of forests, and determination of the damage caused by fire, trespass, etc. This information will also form the basis for the establishment of certain laws of tree growth.

Procedure.—Measurements of volume, growth, and yield are secured chiefly in connection with the timber sales on the national forests, as well as by periodic measurement of trees in permanent sample plots.

Location.—Washington, D. C., forest experiment stations, and national forests.

Date begun.—This work dates from the beginning of the Division of Forestry (1886), but has received more impetus within the last four years.

Results.—(1) During 1916: Notable progress was made in the preparation of additional volume, growth, and yield tables, of which 140 were completed, and in the working up of permanent sample plot data.

(2) Prior to 1916: Altogether there have been prepared some 1,710 tables of volume, growth, and yield covering 100 different species. In addition, there have been established over 300 sample plots in the various forest regions of the United States for the study of growth and yield of stands.

Assignment.—W. B. Barrows, C. G. Bates, T. T. Munger, W. D. Sterrett.

Proposed expenditures, 1916-17.—\$7,650.

Protection Studies:

Object.—To determine the best methods of protecting standing timber and natural reproduction from damage by fire, grazing, disease, insects, animals, and climatic agencies, such as snow, hail, and wind.

Procedure.—The work is done in cooperation with several bureaus of the department. The Office of Forest Pathology, of the Bureau of Plant Industry, has assigned forest pathologists to three national-forest districts (Districts 1, 3, and 5), in addition to one pathologist specializing in nursery diseases, who looks after the nurseries of all the districts. The forest pathologists are under the supervision of the Office of Forest Pathology but work on problems which are most urgent in the management of the national forests.

Cooperation.—Weather Bureau and Bureaus of Plant Industry, Entomology, and Biological Survey.

Location.—Forest experiment stations and national forests.

Date begun.—1910.

Results.—(1) During 1916: The most important development in the work during the fiscal year 1916 has been the undertaking of a comprehensive study of the forest-fire hazard and liability on the national forests, with special reference to the equitable distribution of fire-fighting funds on the basis of the value of the forest resources and the danger of their destruction.

(2) Prior to 1916: In general the work to date has resulted in modifying and greatly improving the efficiency of the protection afforded the national forests against fire, insects, and disease.

Assignment.—A. J. Jaenicke, W. N. Sparhawk, J. A. Mitchell.

Proposed expenditures, 1916-17.—\$2,900.

Tree Studies:

Object.—To secure information concerning the characteristics and life histories of the important forest trees of this country as a basis for their proper management.

Procedure.—This information is collected largely in connection with the timber-sales work on the national forests, management studies, planting studies, studies of forest types, and similar studies. It is mainly a compilation of all the available information on the important timber trees of the United States. Studies of five species are now in progress.

Location.—Washington, D. C., and district headquarters.

Tree Studies—Continued.*Date begun.*—1886.

Results.—(1) During 1916: Several important studies were completed and the following publications issued: Department Bulletins 234, "Utilization and Management of Lodgepole Pine in the Rocky Mountains"; 244, "Life History of Shortleaf Pine"; 272, "The Southern Cypress"; 299, "The Ashes: Their Characteristics and Management"; 308, "Shortleaf Pine: Its Economic Importance and Forest Management"; and 316, "Willows: Their Growth, Use, and Importance."

(2) Prior to 1916: Previous work has resulted in the publication of bulletins or silvical leaflets on the majority of the important timber trees of the United States.

Assignment.—Raphael Zon, E. H. Frothingham, W. D. Sterrett, D. R. Brewster.
Proposed expenditures, 1916-17.—\$14,050.

Wood-Lot Studies and Demonstrations:

Object.—To bring about better marketing of wood-lot products by wood-lot owners and also the better silvicultural handling of the wood lots.

Procedure.—After a study of existing conditions in a region or State, one or more men will be assigned to bring home to the wood-lot owners the points essential for them to keep in mind and the procedure to follow in order to accomplish their object. These Forest Service men will generally work in cooperation with the county agricultural agents of each State. They will give demonstrations in marketing wood-lots products and in silvicultural practice, and in a number of counties will prepare county working plans for the guidance of the county agents in giving advice to farmers. During the present year the work will be concentrated in the Northeastern, Southeastern, and Lake States.

Cooperation.—Through the States Relations Service with extension departments of State agricultural colleges; and also, wherever possible, with boards of trade, farmers' unions, and any other organizations interested in the welfare of the farmer.

Location.—Headquarters at Washington, D. C. (See also "Results.")

Date begun.—1914.

Results.—(1) During 1916: Field work was conducted in Indiana, Tennessee, Georgia, and South Carolina. A wood-lot bulletin prepared by the Forest Service was published by the State of Kentucky. Farmers' Bulletins 711, "Care and Improvement of the Woodlot," and 715, "Measuring and Marketing of Wood-Lot Products," have been issued, and the manuscript for a third bulletin, entitled "The Status and Value of Farm Woodlots," has been prepared.

(2) Prior to 1916: The work has been notably successful in arousing farmers to the importance of better methods of handling their woodlots and the more profitable utilization of their products.

Assignment.—C. R. Tillotson, George N. Lamb, W. R. Mattoon, Benton MacKaye.
Proposed expenditures, 1916-17.—\$6,300.

Farm Wood-Lot Management Survey:

Object.—To secure data over a wide range of the wood-lot section of the United States which will bring out the actual and relative importance of the farm wood lot in the general scheme of farm management.

Procedure.—Nine typical sections of the country will be visited, in each of which 50 to 75 farms will be inspected and certain data obtained which will bring out the foregoing points. It is estimated that it will take one more year to complete this work, when a bulletin will be prepared reporting the results obtained.

Cooperation.—Office of Farm Management.

Location.—Headquarters at Washington, D. C.

Date begun.—1915.

Results.—During the fiscal year 1916 data were secured for New England, Pennsylvania, Indiana, Tennessee, and North Carolina. The data already obtained indicate that for the regions studied the wood lot is valuable as an integral part of the farm and often a most important source of income.

Probable date of completion.—1918.

Assignment.—E. R. Hodson, C. R. Tillotson.

Proposed expenditures, 1916-17.—\$2,250.

Forest Service Library:

Object.—Upkeep of Washington, district, supervisors', and forest experimentation libraries.

Procedure.—Selecting books, with the assistance of the library committee, both for the Washington and field libraries; indexing all books received and all

Forest Service Library—Continued.

periodical articles of interest to the Forest Service; indexing all manuscript reports prepared in the service; preparing a monthly bibliography of current literature and special bibliographies on request; circulating books and periodicals throughout the Washington office; keeping a record of all books and periodicals furnished to field libraries.

Cooperation.—Main department library, Library of Congress, and other Government libraries.

Location.—Washington, D. C., district headquarters, national forests, and forest experiment stations.

Date begun.—1899.

Results.—During the fiscal year 1916, 832 books and pamphlets were added to the Washington library and 686 to field libraries. A total of 18,750 publications on forestry are now included in the Washington library and 30,500 in field libraries.

Assignment.—Raphael Zon, H. E. Stockbridge.

Proposed expenditures, 1916-17.—\$2,820.

Computation:

Object.—Computation of field measurements and various other miscellaneous data for the entire Forest Service.

Procedure.—The data secured by the field force are worked up by the computing clerks in accordance with definite written instructions under the supervision of a technical forester.

Location.—Washington, D. C.

Date begun.—1901.

Results.—During the fiscal year 1916, 18,700 forest measurements were worked up. These were elaborated into 39 volume, 31 yield, 32 growth, 16 form, 2 height, and 20 miscellaneous tables; 260 copies of tables were distributed in answer to inquiries from lumbermen, timberland owners, and foresters. Some 1,710 tables have now been prepared covering with varying degrees of thoroughness all of the important timber trees in the United States.

Assignment.—W. B. Barrows.

Proposed expenditures, 1916-17.—\$9,360.

Development of Private Forestry:

Object.—Development of such lines of improved management through suggestion, experiment, and demonstration as may be found practicable without attempting elaborated or comprehensive working plans.

Procedure.—This work consists of keeping in constant touch with timberland owners and operators in the more important regions, attending their meetings, cultivating their acquaintance, making arrangements for experiments and demonstrations when practicable, and giving suggestions and advice on specific improvements in handling timberlands or conducting logging operations and the like.

Location.—Washington, D. C.

Date begun.—1898.

Results.—Examination has been made of a number of tracts where forestry is now being practiced.

Assignment.—E. S. Bryant.

Proposed expenditures, 1916-17.—\$3,800.

State Cooperation:

Object.—To assist States in conserving their forest resources and to compile and codify State forestry laws.

Procedure.—Correspondence is conducted with State officials and field examinations and reports on special problems are made. Laws are codified according to subjects showing what the State has or has not done in the way of forestry legislation.

Cooperation.—State forestry departments, private forestry associations, and similar organizations.

Location.—Washington, D. C.

Date begun.—1898.

Results.—A large number of States have been encouraged to adopt sound forest policies through the passage of progressive legislation. The compilation of State forestry laws has had wide educational results and has shown which States have adopted the most advanced and practical forestry laws.

Assignment.—J. G. Peters, L. S. Murphy, J. S. Peyton.

Proposed expenditures, 1916-17.—\$6,000.

Total, Silvicultural Investigations, \$118,618, including \$30,340 statutory and \$9,550 from appropriation for planting national forests.

[Regulation.]

RECONNOISSANCE OF RESOURCES.**Timber Surveys:**

Object.—To determine national-forest timber resources, particularly available timber supplies.

Procedure.—Under organized crews estimates of the standing timber are made, silvical and logging data essential to timber sales secured, and topographic and cultural data obtained for base maps of the area.

Location.—Washington, D. C., district offices, and national forests.

Date begun.—1905.

Results.—During the fiscal year 1915 estimates, surveys, maps, and detailed data on the character and condition of the timber and methods of exploitation were obtained for 1,781,803 acres of national-forest land.

Assignment.—W. B. Greeley, district foresters, and forest supervisors.

Proposed expenditures, 1916-17.—\$47,000.

Range Reconnaissance:

Object.—To determine the carrying capacity of the range and to work out and apply plans for grazing management and range development and improvement.

Procedure.—The following data are secured and compiled in the form of maps with notes: (1) The kind of stock for which a range is best adapted, (2) the location of unused, partially used, and overgrazed range, and the changes necessary to bring about proper use, (3) the location of poison-plant areas and areas infested with range-destroying rodents, (4) the location and availability of possible sources of water supply, and (5) the proper grazing season for the range.

Cooperation.—Bureaus of Plant Industry and Biological Survey.

Location.—National forests.

Date begun.—1907.

Results.—See "Grazing" results under "National-Forest Administration."

Assignment.—James T. Jardine, A. E. Aldous, Wm. A. Dayton, H. S. Youngs, L. H. Douglas, R. R. Hill, Mark Anderson, T. D. Douthitt.

Proposed expenditures, 1916-17.—\$18,600.

Total, Reconnaissance of Resources, \$65,600, including \$5,600 statutory.

[Research.]

PREPARATION AND MAINTENANCE OF GRAPHIC, PHOTOGRAPHIC, AND STATISTICAL RECORDS, AND PUBLICATION OF RESULTS.**Geography:**

Object.—Preparation and supervision of forest map and photographic work and compilation of forest statistics.

Procedure.—The Office of Geography includes the Sections of Atlas, Drafting, and Photography. Topographic and outline maps for use in the administration of the national forests are prepared from field sheets or notes, and the lithographing of the maps is performed in the Geological Survey plant. Negatives taken in the field by forest officers are developed and photo prints made therefrom upon requisition and approval by the proper officials. Statistics of various administrative transactions are annually called for from each forest for compilation and preservation in permanent volumes of the forest atlas.

Cooperation.—Geological Survey, General Land Office, Coast and Geodetic Survey, and Census Bureau.

Location.—Washington, D. C.

Date begun.—1907.

Results.—During the fiscal year 1915 the principal work accomplished was as follows: Cooperation in the preparation of lithographic plates and the printing of 181,758 copies of forest maps; compilation of the statistical volume of the forest atlas; forest and title classification and silvicultural maps, 1,229; topographic and outline maps, 896; miscellaneous drawings, 652; negatives developed, 3,890; photo prints made, 47,566; bromide enlargements and transparencies, 619; lantern slides, 1,868; maps mounted, 9,557.

Assignment.—Charles A. Kolb.

Proposed expenditures, 1916-17.—\$65,340.

Editorial Work:

Object.—Supervision and conduct of activities for diffusing a general knowledge of the principles and practice of forestry, preparation of Forest Service manuscripts for publication, proofreading, handling of requests for publications and of job printing, and development, custody, and use of exhibit material and lantern slides.

Procedure.—Information of educational value is diffused through exhibits, addresses, the press, and cooperation with educators, schools, and institutions. Manuscripts for publication are given a technical and literary review.

Cooperation.—Exposition authorities desiring the use of exhibit material without cost to the Government; teachers and others desiring the use of lecture materials or sets of photographs for purposes of public instruction.

Location.—Washington, D. C.

Date begun.—1905.

Results.—In 1915 this office prepared for official publication 38 manuscripts; cared for all printing matters; distributed information; made 245 loans of lantern slides, 19 loans of exhibit material, and 107 loans of sets of photographic and wood sections to school and library authorities; colored 982 lantern slides, 84 bromides, and 40 transparencies, and made 40 botanical drawings.

Assignment.—H. A. Smith.

Proposed expenditures, 1916-17.—\$34,800.

Total, Preparation and Maintenance of Graphic, Photographic, and Statistical Records, and Publication of Results, \$100,140, including \$67,000 statutory.

[Regulation.]

IMPROVEMENT OF THE NATIONAL FORESTS.**Improvements:**

Object.—Construction and repair of roads, trails, telephone lines, firebreaks, fences, corrals, buildings, bridges, water improvements, etc.

Procedure.—Forest supervisors recommend improvement projects regarded as necessary for national-forest administration and after approval by the district forester the work is performed under the immediate supervision of the supervisor and the local ranger force and such specialized assistants as can be furnished from the district forester's office.

Cooperation.—States, counties, telephone companies, and other organizations in the construction and maintenance of roads, trails, telephone lines, etc.

Location.—National forests.

Date begun.—1907.

Results.—The estimated value of permanent improvements on the national forests at the close of the fiscal year 1915 was \$5,211,323. These include 2,528 miles of road, 22,124 miles of trails, 20,030 miles of telephone lines, 1,000 miles of firebreaks, and nearly 2,000 field quarters, besides miscellaneous improvements constructed for protection purposes and to assist in the administration of the grazing business. In addition to facilitating administration and increasing protection with lower operating cost, the construction of permanent improvements on the forests has resulted in direct and immediate public benefit by making accessible and usable a large acreage of country which would not otherwise have been opened up for many years.

Assignment.—James B. Adams, district foresters, and forest supervisors.

Proposed expenditures, 1916-17.—\$400,000.

[Regulation.]

COOPERATIVE FIRE PROTECTION (WEEKS LAW).**Cooperative Fire Protection:**

Object.—To cooperate in the protection from fire of the forested watersheds of navigable streams, under section 2 of the Weeks law (March 1, 1911).

Procedure.—An agreement is made with each State, under which Federal expenditures are incurred for the employment of forest-fire patrolmen, provided the State expends at least an equal amount for fire-protection purposes.

Cooperation.—States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Maryland, Virginia, West Virginia, Kentucky, North Carolina, Texas, Michigan, Wisconsin, Minnesota, South Dakota, Montana, Idaho, Washington, and Oregon.

Location.—Washington, D. C.

Date begun.—1911.

Cooperative Fire Protection—Continued.

Results.—New fire-protection contracts were entered into with four additional States during the fiscal year 1916. Approximately 13,000,000 acres of forest land have been protected from fire, and the people have been educated to the needs of fire protection.

Assignment.—J. G. Peters, L. S. Murphy.

Proposed expenditures, 1916-17.—\$100,000.

[Regulation.]

ROADS AND TRAILS FOR STATES.**Road Construction under the 10 Per Cent Appropriation:**

Object.—Construction and maintenance of roads, trails, and bridges within the national forests for the purpose of opening new territory to settlement and of providing means of communication and transportation to settlers within or adjacent to the national forests.

Procedure.—General plans for road construction are prepared for each State to which the appropriation is applicable. Roads are constructed in the order of their importance as fast as funds are available.

Cooperation.—Office of Public Roads and Rural Engineering, county and other local governments, corporations, and individuals.

Location.—All national-forest States and Alaska.

Date begun.—1912.

Results.—During the past year about 250 miles of road and 20 miles of trail were built or repaired.

Assignment.—O. C. Merrill, district foresters, and road engineers.

Proposed expenditures, 1916-17.—\$284,000.

[Regulation.]

ACQUISITION OF LANDS UNDER THE WEEKS LAW.**Examination and Purchase:**

Object.—To acquire lands for national-forest purposes on the headwaters of important navigable streams.

Procedure.—Twenty-one purchase areas, comprising 6,966,000 acres, have been designated within which the Forest Service invites proposals of land, examines and values tracts which are offered, and recommends purchases to the National Forest Reservation Commission, which approves and fixes the prices to be paid.

Cooperation.—Under the act of March 1, 1911, the Geological Survey is required to examine lands considered for purchase and to show whether they are influential in the protection of the navigability of navigable streams. After approval by the National Forest Reservation Commission the Office of the Solicitor conducts the title examinations and submits reports upon titles to the Attorney General, who must approve the titles to all lands before they can be acquired.

Location.—Lands are being acquired in the following purchase areas, with headquarters as stated:

PURCHASE AREAS.

State.	Name of area.	Headquarters.
New Hampshire.....	White Mountain.....	Gorham, N. H.
Georgia.....	Georgia.....	Blue Ridge, Ga.
	Savannah.....	Clayton, Ga.
North Carolina.....	Boone.....	Marion, N. C.
	Mount Mitchell.....	Do.
	Pisgah.....	Asheville, N. C.
	Savannah.....	Clayton, Ga.
	Nantahala.....	Andrews, N. C.
South Carolina.....	Savannah.....	Clayton, Ga.
Tennessee.....	Smoky Mountain.....	Townsend, Tenn.
	White Top.....	Abingdon, Va.
	Cherokee.....	Etowah, Tenn.
	Unaka.....	Johnson City, Tenn.
Virginia.....	Shenandoah.....	Harrisonburg, Va.
	Natural Bridge.....	Buena Vista, Va.
	Potomac.....	Woodstock, Va.
	Massanutten.....	Do.
	White Top.....	Abingdon, Va.
West Virginia.....	Potomac.....	Woodstock, Va.
	Shenandoah.....	Harrisonburg, Va.
	Monongahela.....	Elkins, W. Va.

Examination and Purchase—Continued.*Date begun.*—1911.

Results.—To June 30, 1915, 1,317,551 acres had been approved for purchase at an average price of \$5.22 per acre, involving an expenditure of \$6,885,901.30, of which 282,900 acres were approved for purchase during the fiscal year 1915, at an average price of \$5.72 per acre.

Assignment.—William L. Hall.

Proposed expenditures, 1916-17.—\$1,260,920, including \$255,000 balance from the original appropriation for the acquisition of lands; includes also \$5,920 statutory.

[Regulation.]

LAND EXCHANGE.**Land Exchange:**

Object.—Consolidation of national-forest lands by exchange with States or persons owning lands within national-forest boundaries, upon the basis of equal values and areas, to obtain economy and efficiency in administration and protection of the lands of each of the parties.

Procedure.—Under special acts of Congress, field examinations by appraisers are made of lands to be exchanged. Reports of examiners are submitted through the district forester's office to the Forester for approval of the Secretary of Agriculture. When approved the Secretary of the Interior is asked to accept reconveyances of private or State lands and issue patents to the Government lands agreed upon in exchange.

Cooperation.—Department of the Interior.*Location.*—Washington, D. C., district headquarters, and national forests.*Date begun.*—1909.

Results.—During the past year the work has been completed upon the Montana State land exchange and the detailed report approved by representatives of the State and the Forest Service. The area involved is 106,608 acres. With the State of Michigan final action has been taken upon an exchange involving 41,493 acres, and a list of the areas to be exchanged has been transmitted to the Department of the Interior. The field work for the remaining areas to be exchanged has also been practically finished. The total area involved in the entire exchange is 86,000 acres. Under authority of a special appropriation of \$50,000 for that purpose, an examination is being made of approximately 485,000 acres of land in the national forests of Washington to which the State would have obtained title except for the forest withdrawal. In lieu of these lands the State expects to secure compact bodies of land in the aggregate equal in area and value to such scattered holdings. The State has also appropriated \$50,000 for examination expenses. Up to date the field examination, maps, and reports have been completed for a total of 233,000 acres. The work on the remaining 252,000 acres is in various stages of completion, but it is expected that the field work will be finished before July 1, 1916.

Assignment.—E. A. Sherman, district foresters, and forest supervisors.

Proposed expenditures, 1916-17.—Unexpended balance of original \$50,000 appropriation, now estimated at \$10,000.

ALLOTMENTS OF FOREST SERVICE APPROPRIATIONS BY UNITS OF ORGANIZATION.

Washington, D. C.:	
General office and field work.....	\$494, 268
Madison laboratory.....	128, 520
Appalachian.....	255, 000
State cooperative fire protection.....	100, 000
Fire fund.....	150, 000
Total.....	1, 127, 788

District 1, Missoula, Mont.:	
District office and field work.....	103, 470
National forests—	
Absaroka.....	19, 503
Beartooth.....	16, 187
Beaverhead.....	18, 496
Bitterroot.....	22, 967
Blackfeet.....	24, 794
Cabinet.....	18, 478
Clearwater.....	20, 643
Coeur d'Alene.....	49, 322
Custer.....	9, 700
Deerlodge.....	40, 813
Flathead.....	40, 700
Gallatin.....	15, 673
Helena.....	17, 337
Jefferson.....	24, 364

District 1, Missoula, Mont.—Continued.	
National forests—Continued.	
Kaniksu.....	\$32, 448
Kootenai.....	33, 153
Lewis and Clark.....	16, 315
Lolo.....	26, 439
Madison.....	16, 039
Missoula.....	16, 713
Nezperce.....	23, 532
Pend Oreille.....	21, 982
St. Joe.....	23, 030
Selway.....	23, 912
Sioux.....	9, 134
Improvement fund.....	82, 000
Roads and trails for States.....	57, 400
Reserve (fire protection, etc.).....	7, 711
Land classification.....	15, 585
Entry survey.....	17, 900
Products.....	2, 600
Range investigation.....	1, 500
Planting fund.....	42, 695
Silvical investigation.....	8, 000
Reconnaissance.....	13, 621
Total.....	934, 156

ALLOTMENTS OF FOREST SERVICE APPROPRIATIONS BY UNITS OF ORGANIZATION— Continued.

District 2, Denver, Colo.:	
District office and field work.....	\$87,610
National forests—	
Arapaho.....	19,297
Battlement.....	14,471
Bighorn.....	19,237
Black Hills.....	30,873
Bridger.....	12,259
Cochetopa.....	14,818
Colorado.....	12,659
Durango.....	14,784
Gunnison.....	17,923
Harney.....	20,363
Hayden.....	14,368
Holy Cross.....	17,397
Leadville.....	15,178
Medicine Bow.....	14,950
Michigan.....	8,435
Minnesota.....	9,590
Montezuma.....	15,734
Nebraska.....	10,050
Pike.....	32,633
Rio Grande.....	20,972
Routt.....	19,351
San Isabel.....	15,733
San Juan.....	13,566
Shoshone.....	19,681
Sopris.....	17,450
Superior.....	21,709
Uncompahgre.....	19,800
Washakie.....	21,955
White River.....	19,905
Improvement fund.....	45,500
Roads and trails for States.....	48,800
Reserve (fire protection, etc.).....	9,539
Land classification.....	17,600
Entry surveys.....	16,200
Range investigation.....	1,140
Planting fund.....	40,000
Silvical investigation.....	9,150
Reconnaissance.....	7,530
Total.....	788,210
District 3, Albuquerque, N. Mex.:	
District office and field work.....	84,600
National forests—	
Alamo.....	13,548
Apache.....	23,004
Carson.....	24,949
Chiricahua.....	7,020
Cocconino.....	36,049
Coronado.....	20,969
Crusk.....	12,224
Datil.....	30,060
Gila.....	24,607
Lincoln.....	13,354
Manzano.....	13,687
Prescott.....	23,673
Santa Fe.....	38,330
Sitgreaves.....	20,692
Tonto.....	18,791
Tusayan.....	25,816
Improvement fund.....	41,000
Roads and trails for States.....	43,500
Reserve (fire protection, etc.).....	4,967
Land classification.....	15,000
Entry survey.....	18,500
Range investigation.....	1,110
Planting fund.....	9,060
Silvical investigation.....	9,500
Reconnaissance.....	11,000
Total.....	585,005

District 4, Ogden, Utah:	
District office and field work.....	84,420
Supply depot and property audit.....	126,880
National forests—	
Ashley.....	14,820
Boise.....	18,101
Cache.....	17,907
Caribou.....	15,503
Challis.....	13,893
Dixie.....	8,345
Fillmore.....	16,687
Fishlake.....	14,820

District 4, Ogden, Utah—Continued.	
National forests—Continued.	
Humboldt.....	\$12,250
Idaho.....	21,285
Kaibab.....	6,808
La Sal.....	10,255
Lemhi.....	13,455
Manti.....	21,350
Minidoka.....	14,509
Nevada.....	9,677
Palisade.....	12,125
Payette.....	21,568
Powell.....	12,145
Ruby.....	3,295
Salmon.....	20,077
Santa Rosa.....	6,735
Sawtooth.....	14,899
Serier.....	13,610
Targhee.....	16,931
Teton.....	13,504
Toiyabe.....	10,917
Uinta.....	20,887
Wasatch.....	19,000
Weiser.....	19,967
Wyoming.....	14,113
Improvement fund.....	53,500
Roads and trails for States.....	48,184
Reserve (fire protection, etc.).....	5,000
Land classification.....	14,940
Entry surveys.....	7,745
Range investigation.....	7,000
Planting fund.....	25,587
Silvical investigation.....	2,400
Reconnaissance.....	9,040
Total.....	834,134

District 5, San Francisco, Cal.:	
District office and field work.....	112,626
National forests—	
Angeles.....	44,755
California.....	24,328
Cleveland.....	24,056
Eldorado.....	18,301
Inyo.....	11,236
Klamath.....	29,759
Lassen.....	27,109
Modoc.....	18,056
Mono.....	10,986
Monterey.....	10,197
Plumas.....	38,261
Santa Barbara.....	30,535
Sequoia.....	33,471
Shasta.....	30,882
Sierra.....	32,752
Stanislaus.....	30,738
Tahoe.....	38,563
Trinity.....	32,825
Improvement fund.....	76,200
Roads and trails for States.....	31,870
Reserve (fire protection, etc.).....	29,216
Land classification.....	12,000
Entry survey.....	5,000
Products.....	8,900
Range investigation.....	1,000
Planting fund.....	7,850
Silvical investigation.....	7,950
Reconnaissance.....	2,000
Miscellaneous forest investigations.....	1,400
Total.....	782,822

District 6, Portland, Oreg.:	
District office and field work.....	105,280
National forests—	
Cascade.....	18,226
Chelan.....	12,029
Chugach.....	19,829
Columbia.....	17,682
Colville.....	16,705
Crater.....	35,388
Deschutes.....	20,576
Fremont.....	17,627
Malheur.....	15,933
Minam.....	12,320
Ochoco.....	15,347
Okanogan.....	18,964

ALLOTMENTS OF FOREST SERVICE APPROPRIATIONS BY UNITS OF ORGANIZATION— Continued.

District 6, Portland, Oreg.—Continued.

National forests—Continued.

Olympic.....	\$21,834
Oregon.....	32,709
Rainier.....	25,135
Santiam.....	15,225
Siskiyou.....	22,969
Siulaw.....	13,714
Snoqualmie.....	24,366
Tongass.....	27,830
Umatilla.....	13,015
Umpqua.....	19,603
Wallowa.....	19,361
Washington.....	15,782
Wenaha.....	12,712
Wenatchee.....	21,530
Whitman.....	27,025
Improvement fund.....	85,500
Roads and trails for States.....	46,850
Reserve (fire protection, etc.).....	8,555
Land classification.....	17,202
Entry survey.....	16,000
Products investigation.....	12,760
Planting fund.....	33,150
Silvical investigation.....	6,500
Reconnoissance.....	15,000
Land exchange (Washington).....	10,000

Total..... 890,233

District 7, Washington, D. C.:

District office and field work..... 20,460

National forests—

Arkansas.....	24,840
Florida.....	16,336
Luquillo.....	1,500
Ozark.....	19,847
Wichita.....	5,803

New forest areas:

Boone.....	1,100
Cherokee.....	4,802
Georgia.....	4,326

District 7, Washington, D. C.—Contd.

National forests—Continued.

Massanutten.....	\$3,277
Monongahela.....	3,655
Mount Mitchell.....	5,643
Nantahala.....	4,565
Natural Bridge.....	5,742
Pisgah.....	8,252
Potomac.....	3,239
Savannah.....	6,686
Shenandoah.....	6,397
Unaka.....	4,165
White Mountains.....	10,368
White Top.....	4,304
Improvement fund.....	13,500
Reserve (fire protection, etc.).....	2,956
Land classification.....	6,300
Forest products.....	2,100
Planting fund.....	1,000
Reconnoissance.....	5,600
Roads and trails for States.....	7,396

Total..... 204,159

Grand total..... 6,146,507

Unallotted contingents:

Improvements.....	\$1,300
Land classification.....	5,773
Surveys, etc.....	1,805
Planting.....	6,958
Silvical investigations.....	1,500
Miscellaneous investigations.....	1,220
Reconnoissance.....	1,209
General administration, etc.....	29,063
Maintenance and supplies.....	1,400
Forest products.....	1,500
Range investigations.....	500

52,228

Total, Forest Service..... 6,198,73

BUREAU OF CHEMISTRY.

GENERAL ADMINISTRATION.

Office of Chief:

Object.—General administration of the research, regulatory, and business affairs of the bureau.

Cooperation.—Other bureaus of the department.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—C. L. Alsberg.

Proposed expenditures, 1916-17.—\$14,000.

Office of Assistant Chiefs:

Object.—To assist the chief in bureau administration.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—R. L. Emerson, W. P. Jones.

Proposed expenditures, 1916-17.—\$30,000.

Office of Chief Clerk:

Object.—To supervise the clerical work of the bureau.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—F. B. Linton.

Proposed expenditures, 1916-17.—\$4,500.

Editorial Work:

Object.—Preparation of manuscripts for publication.

Cooperation.—Division of Publications.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—R. H. Fuller.

Proposed expenditures, 1916-17.—\$3,000.

Library:

Object.—To circulate the books and periodicals of the bureau library and to secure books and information desired by the workers from libraries in and outside of Washington; to buy and care for books and journals bought with bureau funds for the field laboratories; to index and translate food and drug legislation; reference and bibliographical work.

Cooperation.—Department library; other libraries in and out of Washington.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—A. E. Draper.

Proposed expenditures, 1916-17.—\$5,000.

Accounts:

Object.—Supervision and maintenance of financial records of the bureau.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—J. G. Coleman.

Proposed expenditures, 1916-17.—\$10,400.

Supplies:

Object.—Purchase, receipt, maintenance, and distribution of supplies.

Location.—Washington, D. C.

Date begun.—1914.

Assignment.—S. A. Postle.

Proposed expenditures, 1916-17.—\$14,280.

Mail and Files:

Object.—Handling and filing incoming and outgoing mail, and messenger work.

Location.—Washington, D. C.

Date begun.—1907.

Assignment.—P. Perrone.

Proposed expenditures, 1916-17.—\$12,500.

Stenographic Work:

Object.—To assist offices and laboratories in general stenographic and clerical work.

Location.—Washington, D. C.

Date begun.—1914.

Assignment.—L. F. Shipe.

Proposed expenditures, 1916-17.—\$14,000.

Superintendence of Building:

Object.—To perform the mechanical and cleaning work of the bureau.

Cooperation.—Department shops.

Location.—Washington, D. C.

Date begun.—1912.

Assignment.—F. M. Allen.

Proposed expenditures, 1916-17.—\$24,000.

Total, General Administration, \$131,680, including \$88,190 statutory (research, \$43,890; regulation, \$87,790). This total includes \$43,490 from appropriation for enforcement of the food and drugs act.

[Research.]

INVESTIGATIONS IN AGRICULTURAL CHEMISTRY.**CHEMISTRY OF PLANT GROWTH.****Chemistry of Plant Growth:**

Object.—To determine the effect of recognized plant-food constituents and of other inorganic elements applied at different stages, also the effect of light, on the composition and physical characteristics of plants and on the changes in composition which take place during the growing period of plants.

Procedure.—Seedlings are grown in culture solutions and analyzed at different stages, and greenhouse or field crops are treated with different plant foods or subjected to varying conditions of light and shade and the resultant plants analyzed. Field or greenhouse crops are analyzed at different periods of growth.

Cooperation.—Office of Cereal Investigations, Bureau of Plant Industry, and Kentucky Experiment Station.

Location.—Washington, D. C., and Lexington, Ky.

Date begun.—1909.

Results.—(1) During 1916: The results of applying nitrates in solution to growing wheat in the field at different stages of growth indicated a marked increase in protein content.

(2) Prior to 1916: The influence of the calcium-magnesium ratio on root development has shown that the root growth was not affected under the conditions of the bureau's experiments by differences of calcium or of magnesium in the solution culture.

Bureau of Chemistry Bulletin 138, "Translocation of Plant Food and Elaboration of Organic Plant Material in Wheat Seedlings," showed that chemical changes take place during the first three weeks of the plant's growth, beginning with the seed before germination. The plants were treated with solutions of nitrate, potash, and phosphoric acid. The absorption of these plant foods was noted at different stages of growth. The published results showed the amount of inorganic material absorbed and how the formation of new organic material was brought about.

Bureau of Chemistry Bulletin 149, "The Growth of Wheat Seedlings as Affected by Acid or Alkaline Conditions," showed that a continuous application of ammonium sulphate or potassium sulphate or chlorid renders the soil so acid as to cause the crop to be almost an absolute failure, thus corroborating field experiments made at various experiment stations in this country and in England.

The results further showed that the addition of lime or of iron or aluminum hydrate to culture media containing potassium chloride, potassium sulphate, or ammonium salts had a tendency to keep these solutions alkaline. This would tend to explain why field applications of sulphate or muriate of potash in time render the soil acid, unless lime is also applied, while the continued use of Chile saltpeter produces an alkali condition of the soil.

Greenhouse experiments carried on to determine whether starchy grains or flinty grains can be grown at will show that it is quite possible to produce a

Chemistry of Plant Growth—Continued.

starchy grain of the so-called yellow berry by keeping the soil saturated with water. The result of this work shows that the starchy grains are not hereditary and that the production of yellow berry is not due to diseases but is due primarily to the excess of water available to the growing plant.

The investigation conducted in water cultures on the effect of lime on the alkali tolerance of wheat seedlings showed that the presence of lime in small amounts was capable of overcoming the toxicity of alkali salts. In this investigation it was also shown that the benefit which lime exerts is not one of preventing the absorption of the toxic alkali salts by the growing plant, but rather one in which the toxicity of the alkali salts seems to be overcome by the presence of the lime.

As a result of the collaborative work with the Bureau of Plant Industry on the study of the causes of the mottle leaf in the citrus regions of California, it appears that this mottle-leaf disease may be due to the presence of a large amount of lime and at the same time to the absence of a sufficient amount of organic material in the soil.

Assignment.—J. Davidson.

Proposed expenditures, 1916-17.—\$1,600, including \$200 statutory.

(Influence of an Early Application of Plant Food on Growth and Composition: Discontinued as a separate project; included under "Chemistry of Plant Growth.")

(Study of the Chemistry of Plants during Their Growing Period: Discontinued as a separate project; included under "Chemistry of Plant Growth.")

(Changes in Growing Plants under Controlled Chemical and Physical Treatment: Discontinued as a separate project; included under "Chemistry of Plant Growth.")

INFLUENCE OF ENVIRONMENT ON CROPS AND PLANTS.**Influence of Environmental Factors on the Composition of Crops:**

Object.—To determine the rôle played by the kind and quality of seed and the influence of climatic agencies and of the soil on the composition of crops and on their physical characteristics.

Procedure.—In the bureau's so-called triloc experiments a definite sample of seed is grown in each of three localities varying greatly in climatic conditions. From each of the resultant crops seed is then grown in each locality in small plots side by side and the crops analyzed.

In the triloc soil-exchange experiments small plots of soil are interchanged between each of three localities, and in each of these three soils in each locality the same seed has been sown and the resultant crop analyzed.

In the regular environmental investigations the composition of the same varieties of plants grown at and obtained from different States or localities is determined.

In order to determine more definitely the influence of soil on the composition of crops, it is proposed to transport to some convenient experiment farm, possibly the Arlington Farm, a definite area of soil of each of several kinds—sandy clay, marl, muck, etc.—and to grow the same crops in each soil.

Cooperation.—Office of Cereal Investigations, Bureau of Plant Industry.

Location.—Washington, D. C., and Maryland, South Dakota, Kansas, Texas, and California experiment stations.

Date begun.—1905.

Results.—(1) During 1916: A manuscript has been prepared for publication on "The Composition of Grain Sorghums," giving the results of analyses of several hundred samples of sorghums grown at Amarillo, Tex., for five successive years. The results show that the composition of the sorghums is very similar to that of the well-known cereals and also show in what manner the composition may be expected to vary from year to year in the Texas Panhandle.

As a result of the study of soy beans in different localities it has been found how the soy beans vary in oil and protein content, how the varieties vary among themselves, and how the climatic conditions prevailing in each locality have affected the composition.

(2) Prior to 1916: Bureau of Chemistry Bulletin 128 gives the results of three years' work, which has in the meantime been confirmed by subsequent investigation. Climate plays the predominant part in influencing the composi-

Influence of Environmental Factors on the Composition of Crops—Continued. tion of grains, and when wheat of the same variety obtained from different sources and possessing widely different chemical and physical characteristics is grown side by side in any one locality, the resultant crops are almost identical in composition and appearance. When wheat of any one variety and from any one source is grown in different localities possessing different climatic conditions, the resultant crops are very different in appearance and in chemical composition. In the bureau's trilocal experiments the crops grown on the three plots at any one locality were identical in appearance and composition, but the crops grown on the three plots of any one locality were different from those grown in each of the other two localities.

The results of the first four years' work on the soil-exchange experiments were published in the *Journal of Agricultural Research*, vol. 1, No. 4 (January, 1914). Continued work has confirmed these results, which indicate that the soil as such plays a minor part in influencing the composition of wheat. For example, the wheat grown on each of the three soils in Maryland varied from 10 to 13 per cent in protein, while on similar soils transported to Hays, Kans., the wheat contained from 18 to 20 per cent of protein. The wheat grown on each of the three plots in Maryland was identical in appearance, but it was entirely different in appearance from the wheat grown on similar soils in Kansas.

In the regular environmental work the results of the analysis of grains grown under different conditions indicate that the climatic conditions prevailing during the growing season affect the composition of the crop. Data on the subject were published in the Department Yearbook for 1906, in an article entitled "The Effect of Climatic Conditions on the Composition of Durum Wheat." It was shown that the durum wheats grown in the semiarid or arid regions contain from 3 to 6 per cent more protein than the same wheats grown in the humid regions.

Assignment.—J. A. Le Clerc, J. Davidson.

Proposed expenditures, 1916-17.—\$3,700.

(Influence of Environment on the Composition of Cereals: Discontinued as a separate project; included under "Influence of Environmental Factors on the Composition of Crops.")

(Influence of Soil and Climate on Plant Composition: Discontinued as a separate project; included under "Influence of Environmental Factors on the Composition of Crops.")

(Influence of Environment on the Composition of Plants Other than Cereals: Discontinued as a separate project; included under "Influence of Environmental Factors on the Composition of Crops.")

(Influence of Different Soils upon the Composition of Wheat: Discontinued as a separate project; included under "Influence of Environmental Factors on the Composition of Crops.")

(Study of the Chemistry of Grains Typical of the Different States: Discontinued as a separate project; included under "Influence of Environmental Factors on the Composition of Crops.")

(Changes in Composition Which Grains Undergo on Storing: Discontinued as a separate project; included under "Influence of Environmental Factors on the Composition of Crops.")

Influence of Stacking, Shocking, and Storing Grain:

Object.—To determine the influence of storing grain and grain products on the composition, and to investigate the effect of shocking and stacking wheat on the quality of the flour milled therefrom.

Procedure.—Samples of grain and grain products, after having been analyzed or tested, are stored away under certain conditions and after a definite period reanalyzed and tested. Wheat and other grain crops are handled in different ways after harvesting, some being stacked and some shocked, and the results of the various treatments are noted by making milling and baking experiments.

Cooperation.—Offices of Grain Standardization and Cereal Investigations, Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1908.

Results.—Some preliminary experiments show that no great change is produced by the storage of ordinary cereals in so far as the protein, fat, fiber, and pentosans content are concerned, but in the case of corn there was a big decrease in the amount of sugar. These results were published in the *Journal of Industrial*

Influence of Stacking, Shocking, and Storing Grain—Continued.

and Engineering Chemistry, 1909, vol. 1, No. 5. The results on stacking and shocking of wheat are not sufficiently complete to warrant drawing any conclusion.

Assignment.—J. A. Le Clerc.

Proposed expenditures, 1916-17.—\$450.

Value of Leaves of Different Species for Manurial Purposes:

Object.—To determine the value of leaves for manurial purposes and the losses of plant constituents when leaves are subjected to rain and other abnormal treatment.

Procedure.—Samples of different varieties of leaves are analyzed in order to determine the amount of plant food contained in them.

Cooperation.—Office of Economic and Systematic Botany, Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1907.

Results.—Results of experiments with leaves show a marked difference in the composition of the various kinds of leaves, and it is therefore to be expected that they would have different manurial value.

Probable date of completion.—1918.

Assignment.—L. H. Bailey.

Proposed expenditures, 1916-17.—\$375.

Loss of Plant Constituents of Hay Due to Weather Conditions:

Object.—To determine the value of hay for feeding purposes and the loss of plant constituents when hay is subjected to rain and other abnormal treatment.

Procedure.—Samples of hay are harvested and are allowed to dry in the field. When dried, a portion of the sample is collected and analyzed and another portion allowed to remain in the field until soaked by rain. The latter portion is then dried again, resampled, and both the well-cured and the badly-cured hay analyzed.

Cooperation.—Office of Forage Crop Investigations, Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1907.

Results.—(1) During 1916: It has been found that considerable amounts of both inorganic and organic substances are leached out of hay and lost through the action of rain.

(2) Prior to 1916: Analyses showed that a large part of the sugar, protein, and ash constituents are lost. Results published in Department Yearbook for 1908, "Plant Food Removed from Growing Plants by Rain or Dew." The general conclusions indicated that the analysis of plants for ash constituents only might give misleading results, if it were desired to determine the amount of plant food absorbed or essential to plant growth, unless the leaching action of rain and dew be considered.

Probable date of completion.—1918.

Assignment.—L. H. Bailey.

Proposed expenditures, 1916-17.—\$375.

Total, Influence of Environment on Crops and Plants, \$4,900, including \$550 statutory.

STUDIES OF MILL PRODUCTS.**Wheat, Flour, and Prepared Cereal Products:**

Object.—To determine (a) the methods for the valuation of wheat flour, bread, macaroni, etc.; (b) the effect of various factors on the quality of flour and prepared products; and (c) the composition of wheat, flour, bread, breakfast foods, and macaroni; and to obtain data which may be used in encouraging the manufacture in this country of a large amount of macaroni from the best grades of semolina.

Procedure.—Mill products of wheat and other cereals obtained in commercial mills and in our own experimental mill are analyzed, in order to determine the character of products which each process produces. The flour made by milling is baked. Other wheat products, such as macaroni and breakfast foods, also are analyzed, in order to obtain knowledge regarding their characteristics. In order to obtain information regarding the best class of wheat used in the production of semolina for the purpose of making macaroni, it is intended to compare the quality of the semolina and of the macaroni produced therefrom abroad and in this country.

Wheat, Flour, and Prepared Cereal Products—Continued.

Coöperation.—Offices of Cereal Investigations and Grain Standardization, Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1909.

Results.—(1) During 1916: Much work has been done with milling wheat, but these data have not yet been assembled and examined for conclusions. The results obtained, however, show the relation between the composition of wheat and flour made therefrom and the difference in composition between the products of the various break and smooth rolls. This study has given an insight into the composition of the various grades of flour and the kind of bread to be expected from each grade.

(2) Prior to 1916: In Bureau of Chemistry Bulletin 164, "Graham Flour," the condition of the trade regarding whole-wheat and graham flour was shown. This study has likewise resulted in the elaboration of a method for distinguishing graham flour from so-called, or misbranded, graham flours. An article entitled "A Report of the Chemical and Bacteriological Study of Wrapped Bread," showing that wrapped bread will keep fresh for at least 72 hours, was published in the American Journal of Public Health, vol. 4, No. 9. Another result of this investigation indicated that the surface of wrapped bread was more nearly free from organisms than that of unwrapped bread. A method for making good yeast bread has been worked out.

Assignment.—L. H. Bailey, H. L. Wessling.

Proposed expenditures, 1916-17.—\$1,800.

(Wheat and Prepared Cereal Products: Discontinued as a separate project; included under "Wheat, Flour, and Prepared Cereal Products.")

(Study of Semolina Produced from Different Wheats: Discontinued as a separate project; included under "Wheat, Flour, and Prepared Cereal Products.")

Keeping Quality of Flour under Insect-Control Treatment:

Object.—To obtain information regarding the influence of treatments with carbon dioxid, heat, and vacuum (for the purpose of destroying weevils and other insects infesting flour and cereal products) on the characteristics of the gluten and the baking qualities of the flour.

Procedure.—It is proposed to transfer flour into a number of containers, some of which will be heated, others exhausted of air, and still others, after being exhausted of air, filled with carbon dioxid. These cans will be sealed and kept for a definite period, after which the flours will be examined again and tested for various constituents and for baking qualities. The results then will be compared with those obtained with the same kind of flour kept under normal conditions.

Location.—Washington, D. C.

Date begun.—1916.

Results.—The investigation has not progressed far enough to report results.

Probable date of completion.—1920.

Assignment.—H. L. Wessling.

Proposed expenditures, 1916-17.—\$250.

(Influence of Carbon Dioxid on the Keeping Quality of Flour: Discontinued as a separate project; included under "Keeping Quality of Flour under Insect-Control Treatment.")

(Influence of Vacuum on the Characteristics of Gluten and on the Keeping Quality of Flour: Discontinued as a separate project; included under "Keeping Quality of Flour under Insect-Control Treatment.")

(Influence of Drying Flour in Vacuum on Its Keeping Quality and on the Characteristics of the Gluten: Discontinued as a separate project; included under "Keeping Quality of Flour under Insect-Control Treatment.")

Studies of the Composition and Utilization of the Soy Bean and Its Products:

Object.—To obtain information regarding the composition of soy beans, the method of preparing soy-bean products, and the chemical changes which take place in the preparation of these products.

Procedure.—Soy beans grown in different parts of the country by the Bureau of Plant Industry are analyzed, especially for fat and protein. The various soy beans rich in fat and protein are to be used in investigations to determine which are best suited for the manufacture of various soy-bean products.

Studies of the Composition and Utilization of the Soy Bean and Its Products—Continued.*Cooperation.*—Office of Forage-Crop Investigations, Bureau of Plant Industry.*Location.*—Washington, D. C.*Date begun.*—1915.*Results.*—About 500 samples of soy beans grown in a number of localities and representing approximately a score of varieties have been analyzed, and the results are being tabulated. No definite conclusions can at this time be mentioned, as the results have not been studied sufficiently to draw conclusions.*Probable date of completion.*—1920.*Assignment.*—J. A. Le Clerc.*Proposed expenditures, 1916-17.*—\$250.**Total, Studies of Mill Products, \$2,300, including \$250 statutory. Of this total, \$2,000 is paid from appropriation for enforcement of the food and drugs act.****STUDIES IN BREAD MAKING.****Study of the Methods of Bread Making with Soft Winter-Wheat Flour:***Object.*—To make a good commercial bread from a soft winter-wheat flour, following possibly the methods used in France, where a similar flour is employed in bread making and where the quality of the bread is of the finest.*Procedure.*—It is proposed to obtain information regarding the methods in vogue for the production of the best French bread, and to use these methods in connection with the so-called soft-wheat flours. In doing this it will be necessary to visit bakeries where French bread is made and to obtain information from various other sources.*Cooperation.*—French bakeries in some of our large cities.*Location.*—Washington and certain cities where French bakeries are to be found.*Date begun.*—1916.*Results.*—Too early to report results.*Probable date of completion.*—1920.*Assignment.*—H. L. Wessling.*Proposed expenditures, 1916-17.*—\$600.**Use of Yeast, Malt Extract, and Other Aids in Baking:***Object.*—To investigate the best methods to be used with the different forms of yeast, namely, compressed, dried, and liquid yeast, and so enable the housewife to make good bread with whatever kind she is able to procure; and to study the effect of malt extract and other substances which may improve the quality of flour in bread making.*Procedure.*—It is proposed to use the various kinds of yeast found on the market and to determine the best method of baking by the use of these various yeasts.

It is likewise proposed to obtain the various malt extracts and other aids in baking and to test the efficacy of these in the making of bread.

Location.—Washington, D. C.*Date begun.*—1916.*Results.*—Too early to report results.*Assignment.*—H. L. Wessling.*Proposed expenditures, 1916-17.*—\$900.**Use of Part Substitutes for Flour in Baking:***Object.*—To study the adaptability for bread making of flour substitutes made from chestnuts, bananas, peanuts, soy beans, peas, corn, barley, oats, rye, kafir, dasheen, and other substances.*Procedure.*—As many so-called flour substitutes as it has been possible to obtain are tested to ascertain whether, when used in combination with ordinary flour, a satisfactory loaf of bread can be made. The general procedure is to use 20 to 25 per cent of these flour substitutes with 75 to 80 per cent of a good spring-wheat flour.*Cooperation.*—Offices of Cereal Investigations and Foreign-Crop Investigations, Bureau of Plant Industry.*Location.*—Washington, D. C.*Date begun.*—1913.*Results.*—Experiments have been made with about 30 part substitutes for flour in baking bread which can be profitably used to the extent of 25 parts, together with 75 parts of flour. The composition of these flour substitutes and the breads made with 25 per cent of these substances has been determined. It has been shown that special breads can be made from certain flour substitutes which may

Use of Part Substitutes for Flour in Baking—Continued.

be of great value in localities where these substances are abundantly available. Methods for making bread containing 57 per cent of boiled potato and 43 per cent of good spring-wheat flour have been worked out, the possibility of making a satisfactory loaf of bread with so large a quantity of boiled potato having been fully demonstrated.

Probable date of completion.—1916.

Assignment.—H. L. Wessling.

Proposed expenditures, 1916-17.—\$200.

Total, Studies in Bread Making, \$1,700. This includes \$400 from appropriation for enforcement of the food and drugs act.

MALTING.**Malting:**

Object.—To investigate the quality of malt obtained from different kinds of barley when malted under different conditions.

Procedure.—Samples of different varieties of barleys are to be analyzed and subsequently malted under varying conditions of temperature and moisture and the resultant malts analyzed, in order to determine their value for malting or for the production of malt extract.

Location.—Washington, D. C.

Date begun.—1905.

Results.—After several years' work Bureau of Chemistry Bulletin 124 was published, giving the results of analyses of barleys from the various States and the kind of malt produced therefrom. The malting was done under commercial supervision. Most of the analytical work on the barleys and malt, however, was carried on in the Bureau of Chemistry.

Probable date of completion.—1920.

Assignment.—J. A. Le Clerc.

Proposed expenditures, 1916-17.—\$500.

MISCELLANEOUS ANALYSES.**Miscellaneous Analyses:**

Object.—To determine the composition of plants and plant products submitted for analysis by the Bureau of Plant Industry and by the various laboratories of the Bureau of Chemistry.

Location.—Washington, D. C.

Date begun.—1905.

Results.—During the past year almost 1,900 samples were received, 75 per cent of them coming from the Bureau of Plant Industry. Over 100 samples of flours were submitted by the Marine Corps, Panama Railroad, and other agencies of the Government. Many of the samples received were subjected to analysis of a routine nature, consuming a great deal of the time. About 300 more samples were received last year than during the preceding year.

Assignment.—J. A. Le Clerc, L. H. Bailey.

Proposed expenditures, 1916-17.—\$7,000, including \$920 statutory.

LEATHER AND TANNING INVESTIGATIONS.**Investigations of the Wearing Quality of Sole Leather:**

Object.—To determine the effect of various tanning processes on quality, the relative value of leather made from different sections of the hide, and the quality of various tannages.

Procedure.—Necessary devices will be perfected prior to actual machine tests. Different leathers will be tested to determine their endurance under the test. This work will be continued along these lines until results having practical significance are obtained. Wearing tests and complete analyses of the leathers will also be made. During 1916-17 work to perfect a machine and to secure preliminary results will be continued.

Location.—Washington, D. C.

Date begun.—1913.

Results.—A testing machine has been designed and built and certain necessary attachments satisfactorily proved. Wearing and analytical data have been

Investigations of the Wearing Quality of Sole Leather—Continued.

obtained. Work on the standardization of the machine has continued during 1916, and progress has been made.

Probable date of completion.—1917.

Assignment.—J. S. Rogers, F. M. Allen.

Proposed expenditures, 1916-17.—\$1,200.

Disposal of Tannery and Leather Wastes:

Object.—To utilize profitably tannery and leather wastes, distribute information on the agricultural value of these wastes, and prevent the pollution of drainage waters by such wastes.

Procedure.—Data on tannery-waste disposal and treatment are compiled from various sources. The experience of those who have installed plants is sought, with full data as to efficiency, in order to make the matter of general value. Analyses of recovered products are made to determine their agricultural value. Suggestions and advice are supplied on the subject.

Cooperation.—American Leather Chemists' Association, National Association of Tanners, individual tanneries, and Hygienic Laboratory, Treasury Department.

Location.—Washington, D. C.

Date begun.—1913.

Results.—Information has been compiled showing that it is feasible to purify tannery-waste liquors by well-established and simple processes and that the wastes thus recovered may be disposed of for agricultural purposes, sometimes at a profit. Analyses of a number of wastes and recovered products have been made. A second article covering recent information on tannery wastes has been published in the Journal of the American Leather Chemists' Association. Data are being compiled on the agricultural value of waste, and information has been furnished the tanning industry through correspondence.

Probable date of completion.—1917.

Assignment.—F. P. Veitch, R. W. Frey.

Proposed expenditures, 1916-17.—\$215.

Investigations of the Composition of Leather and Tanning and Finishing Materials:

Object.—To furnish the public useful information relative to the purchase of leather and leather articles, secure helpful information on the composition of these materials, show the relation between the composition and quality of the materials, and improve existing methods of examination and devise new methods where needed.

Procedure.—The materials are examined by chemical, physical, and microscopical methods for normal, abnormal, and harmful constituents, and the effect of the presence of such constituents is noted. Old methods of testing are critically examined and improved or new ones substituted when needed. The work is essential as a foundation for advanced practical work.

Cooperation.—Association of Official Agricultural Chemists, American Leather Chemists' Association, and International Association of Leather Trades Chemists.

Location.—Washington, D. C.

Date begun.—1906.

Results.—(1) During 1916: Cheaper filter paper than that now used has been sought for use in tannin determination, with negative results. Methods for the detection of sulphite cellulose liquors in tanning materials have been tested, with unsatisfactory results. Analyses of leathers, barks, and other tanning materials have been made for research purposes and for other Federal departments.

(2) Prior to 1916: Assistance has been given in the study and improvement of methods of examining tanning materials, oils, and greases, and tanning products in general. The results obtained have been published for the information of chemists from time to time in the Journal of the American Leather Chemists' Association, and Bureau of Chemistry Bulletin 165 on the composition of American sole leather has been issued. During 1915 a quick and exact method for the determination of reducing sugars in leather was completed and published. Methods for the determination of mineral acids in leather are being studied. Preliminary work has been done on the identification of tanning materials in mixtures. A test for the detection of chestnut and white oaks has been improved and the results published in the Journal of the American Leather Chemists' Association.

Assignment.—J. S. Rogers, R. W. Frey.

Proposed expenditures, 1916-17.—\$1,280.

Deterioration of Upper, Bookbinding, and Other Light Leathers:

Object.—To discover the causes of and to prevent the deterioration of light leathers; to eliminate the use of harmful materials in leather making; and to conserve raw materials by making better leather.

Procedure.—Badly deteriorated as well as durable leathers are carefully examined to determine wherein they differ in composition, appearance, and physical condition, for the purpose of explaining the serviceability of the leathers. Cooperation has been established with a number of public libraries to compare the durability of binding leathers in service with the determined composition of the leathers.

Cooperation.—War Department, American Library Association, individual libraries, bookbinders, and tanners.

Location.—Washington, D. C.; libraries in New York City, Providence, R. I., and Newark, N. J.

Date begun.—1912.

Results.—The harmful effects of large quantities of sulphuric acid have been definitely shown; specifications suggested for durable leathers, especially for Government and library purposes; and a number of deteriorated leathers examined.

Probable date of completion.—1917.

Assignment.—J. S. Rogers, R. W. Frey.

Proposed expenditures, 1916-17.—\$1,280.

Tanning Sole and Harness Leather on a Small Scale:

Object.—To ascertain tanning methods which may be successfully and economically used by farmers and small shoe and harness makers in the tanning of sole and harness leathers on a small scale.

Procedure.—Small-scale tannings will be actually made with the simplest equipment, such as may be available on the farm. The procedures, equipment, and results will be minutely described and fully illustrated in a publication.

Cooperation.—Small tanners.

Location.—Washington, D. C.

Date begun.—1916.

Results.—Too early to report results; active work only recently begun.

Assignment.—Assistant to be appointed.

Proposed expenditures, 1916-17.—\$700.

Total, Leather and Tanning Investigations, \$4,675, including \$1,200 statutory.

PAPER INVESTIGATIONS.**Paper Investigations:**

Object.—To demonstrate the more rational and economical use of paper, in order to conserve paper-making materials; to effect economies in and to aid in the intelligent manufacture of paper; to determine the factors which control the serviceability, suitability, and durability of papers; to improve the quality of papers; to aid in furnishing a basis for the intelligent interpretation of the characteristics of paper; and to improve methods and conditions for obtaining more accurate, uniform, and useful results.

Procedure.—Laboratory methods for serviceability, suitability, and durability will be devised and correlated with actual experience. The factors which determine the uses of paper will be carefully studied. From the data thus obtained, improvements in processes of paper making will be devised which will insure paper better suited to specific uses, the more economical and conservative use of paper-making materials will be promoted, and more rational and definite specifications for papers for various purposes can be prepared.

Cooperation.—Government departments, libraries, and selected paper makers.

Location.—Headquarters, Washington, D. C.; brief field work at libraries and paper mills as occasion may arise.

Date begun.—1904.

Results.—(1) During 1916: Investigations on blue-print paper have been of service in establishing more solidly the manufacture of such paper in this country and in enabling the Government and engineers generally to procure in this country high-grade blue-print paper. An accurate method has been devised for determining whether blue-print paper will withstand necessary handling while wet. The reliability of the folding-endurance tester and the conditions under which it must be operated have been determined, and the results obtained have been prepared for publication. A new instrument, serviceable both to the paper maker and to the user of paper, has been devised for measuring the translucency of paper. A description of it has been prepared for publication.

Paper Investigations—Continued.

(2) Prior to 1916: Seven publications have been issued, covering methods and apparatus used in testing. Specifications have been prepared and general information obtained on serviceability, suitability, durability, and economical use, and also on the conservation of raw materials. The general form and substance of the specifications developed in this laboratory have been adopted by the chief Federal purchasing agents as well as by scientific societies and by State governments and corporations. Existing methods and apparatus and conditions for paper testing have been investigated and their value, effects, and results determined. Methods, apparatus, and conditions of testing have been markedly improved. Many somewhat intangible results have followed: More intelligent and fairer competition in bidding on Government supplies; more regular delivery of specified material; use of more suitable paper for the purpose in hand; the more economical and conservative purchase of paper. Savings of many thousands of dollars in the purchases of the Government Printing Office and the Post Office Department and other departments have resulted from the specifying of more suitable or lighter papers following along the lines developed and constantly urged by the bureau in its publications and in its advisory capacity.

Assignment.—F. P. Veitch, C. F. Sammet, E. O. Reed.

Proposed expenditures, 1916-17.—\$1,572, including \$300 statutory.

INVESTIGATIONS OF WOODS AND WOOD PRODUCTS.**Investigations of Woods and Wood Products:**

Object.—To improve methods and apparatus used in wood distillation, shorten the time of distillation, investigate the utilization of waste wood, and encourage the production of marketable articles not heretofore recovered from the wastes, and secure information on processes and yields of products.

Procedure.—Laboratory experiments are conducted to show the kind and quality of products obtained from different species of wood. Laboratory experiments are also under way to show the factors which control the quantity and nature of the products, followed by field work at existing wood-distillation plants looking to improvements in equipment and methods and to increased yields.

Cooperation.—Selected wood distilleries and sawmills, as may appear advisable.

Location.—Headquarters, Washington, D. C.

Date begun.—1901.

Results.—Two publications have been issued giving much general information on the principles, equipment, costs, processes, products, and profits of wood distillation. Field experiments on a commercial-unit size have been conducted on resinous wood, resulting in shortening the time of distillations, thereby decreasing the cost of equipment and increasing production to the same extent. Many data on yields of products have been collected. Examination of products to determine exact yields and to acquire information on the progress and nature of reactions in distillations have been made during the past year and will be concluded in 1917. Values of products not heretofore recovered are being determined.

Probable date of completion.—Experimental work already started to be concluded and data assembled for publication in 1917.

Assignment.—F. P. Veitch, G. C. Spencer.

Proposed expenditures, 1916-17.—\$1,135, including \$250 statutory.

(Distillation of Idaho Wood: Project completed. It was found that stump burning in this section is not economically successful by any known methods. The yield of tar recovered is small and hardly offsets the cost of equipment, the expense of which is greater than the individual farmer can bear. Western yellow pine, more or less rich in resin and from which sap wood was recovered, gave very satisfactory yields of first-quality wood turpentine, pine oil, light oil, heavy oil, pitch, and charcoal. In the southern yellow-pine district of the United States only three distillation plants, using wood and stumps costing at the plant from \$3.50 to \$5 per cord, the average richness of which in resin is at least equal to the best "medium" western yellow pine, have been able to run at a profit when wood turpentine fell below 50 cents per gallon, with other products selling proportionately. This result was accomplished only through efficient technical control and vigorous sales efforts. In the utilization of waste wood by distillation, land clearing is properly incidental to the distillation work, although the receipts from the sale of the wood may pay in part for the cost of clearing the land.)

INVESTIGATIONS OF ROSIN AND TURPENTINE.

Improvement of the Quality of Rosin and Turpentine:

Object.—To promote the production of higher grades of rosin and turpentine, simplify and lower the cost of production, and increase the yield of rosin from the gum.

Procedure.—Laboratory and field experiments and the demonstration of improved methods of distilling and straining will be made, to show that more and higher grades of rosin than it is now customary to produce can be made at possibly less cost by improved procedure. The work will require demonstrations at the stills. It can not be made effective through publications alone.

Cooperation.—Selected naval-stores producers.

Location.—Headquarters, Washington, D. C.; field work at 15 or 20 stills in North Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas.

Date begun.—1913.

Results.—(1) During 1916: Investigations have been made on the proper handling of the raw materials at the still, on distillation and the factors affecting it, the handling of the products, and the utilization of wastes. The data are being prepared for publication. A process for the production of high-grade rosin from the low-grade product has been worked out in the laboratory.

(2) Prior to 1916: Laboratory work has indicated convincingly that much better and more rosin can be made from the gum than is now commonly produced. Field work is being conducted to ascertain how great may be the improvement and the increased value of the product on a commercial scale and to familiarize the producers with the improved methods. The product of several stills has already been improved.

Probable date of completion.—Research work, 1916. Extension work along this line will be carried on.

Assignment.—F. P. Veitch, H. P. Holman, G. C. Spencer.

Proposed expenditures, 1916-17.—\$820.

Investigations of Wood Turpentine:

Object.—To improve the quality of wood turpentine and secure additional information on the value of wood turpentine as a paint and varnish thinner.

Procedure.—Methods are developed on a laboratory scale for the satisfactory refining of wood turpentine. These methods are tried on an industrial scale and brought to the attention of wood-turpentine producers through publications. The experiences of paint and varnish makers and of painters are learned, and painting and varnishing experiments are made with wood turpentine.

Cooperation.—Wood distillers and paint and varnish makers.

Location.—Washington, D. C.

Date begun.—1904.

Results.—(1) During 1916: Improvements which increase the yield and give a product of better quality have been made in the refining of wood turpentine. Acetic acid and methyl alcohol have been recovered from the oils obtained in the distillation of resinous woods. The yields of acid and alcohol usually obtained from these woods are thus nearly doubled.

(2) Prior to 1916: Investigations on the production, refining, and use of wood turpentine as a paint and varnish thinner were made and results published. With this publication as a guide, the wood-turpentine distillers should be able to produce a well-refined marketable product suitable for paint and varnish thinning.

Probable date of completion.—1916.

Assignment.—F. P. Veitch, G. C. Spencer.

Proposed expenditures, 1916-17.—\$352.

Methods of Analysis of Turpentine, Rosin, and Wood Products:

Object.—To devise accurate methods for determining the constituents in these articles, to serve as a basis for research work in production and for the preparation of specifications.

Procedure.—Many methods now used are erroneous. Accurate methods must be secured. These are being devised by very careful trials on samples of known composition.

Cooperation.—American Society for Testing Materials.

Location.—Washington, D. C.

Date begun.—1906.

Methods of Analysis of Turpentine, Rosin, and Wood Products—Continued.

Results.—(1) During 1916: A practical colorimeter for measuring the color of turpentine has been devised, and a paper on the subject has been published. Methods for the examination of crude pyroligneous liquors have been improved, and the data are being prepared for publication.

(2) Prior to 1916: Marked improvements have been made in the methods for the examination of turpentine, pine oils, and certain distillation products. Results are issued in three publications, and data for several others are in hand.

Assignment.—G. C. Spencer, C. F. Speh, H. P. Holman.

Proposed expenditures, 1916-17.—\$493.

Production of Rosin Oil from Resinous Wood:

Object.—To devise methods for the refining and utilization of the heavy oils from resinous-wood distillation.

Procedure.—Methods for refining will be worked out in the laboratory, and these methods will be demonstrated at working plants.

Cooperation.—Wood distillers and rosin-oil users.

Location.—Washington, D. C.

Date begun.—Cursorily, 1901; actively, 1914.

Results.—(1) During 1916: Oils have been produced which are similar in properties to rosin oils now found on the market. The properties and market value of these oils are being investigated.

(2) Prior to 1916: Laboratory work gives warrant for the belief that useful rosin oil can be prepared from the heavy oils produced by the destructive distillation of resinous wood.

Probable date of completion.—1917.

Assignment.—G. C. Spencer.

Proposed expenditures, 1916-17.—\$480.

Total, Investigations of Rosin and Turpentine, \$2,145, including \$550 statutory.

WATERPROOFING AND MILDEWPROOFING FABRICS FOR FARM USE.**Waterproofing and Mildewproofing Fabrics for Farm Use:**

Object.—To give farmers effective and cheap methods of waterproofing and mildewproofing fabrics for wagon covers, stack covers, and other farm uses.

Procedure.—It will be determined whether or not there are effective and cheap methods of waterproofing and mildewproofing which can be used safely and satisfactorily on the farm. If so, simple equipment and methods of procedure will be described so that farmers may carry out these processes satisfactorily. If there are no satisfactory and cheap methods of waterproofing and mildewproofing, an attempt will be made to devise methods, selected processes being submitted to actual use before a final conclusion as to the value of the processes is reached. This will involve small-scale experimental work, both at headquarters and possibly in cooperation with the manufacturers of waterproof and mildewproof fabrics and with one or more of the Government departments. Samples of waterproof and mildewproof fabrics with which Government departments and other users have experimented will be carefully examined in the laboratory, not only for their waterproof and mildewproof properties but to determine the nature of the materials used in waterproofing and mildewproofing.

Cooperation.—Manufacturers of waterproofed and mildewproofed fabrics; other Government departments.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Some data collected.

Probable date of completion.—1917.

Assignment.—H. P. Holman, B. S. Levine.

Proposed expenditures, 1916-17.—\$2,028, including \$520 statutory.

CARBOHYDRATE INVESTIGATIONS.**Investigations in the Manufacture of Sorghum Sirup:**

Object.—To study methods of manufacture of sorghum sirup, with the object of obtaining a method that may be used by the average producer for making a clear, light-colored, mild-flavored sirup; to study methods for the prevention of crystallization; and to study methods of analysis of sorghum sirup.

Investigations in the Manufacture of Sorghum Sirup—Continued.

Procedure.—Sirups are manufactured under various conditions in factories in sorghum-producing centers and analyzed. A study of methods of analysis is carried on in the laboratory at Washington.

Cooperation.—Bureau of Plant Industry, on varieties; and sirup makers located in a large sorghum district.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Sixty-seven samples of sorghum sirups and semisirups and 21 samples of sorghum juice were made and analyzed during October, 1915, in Kentucky and at a plant at Fort Scott, Kans., and processes used and their effect upon the composition of the sirup were studied. Samples collected at these places were used in connection with the study of a new method that has been perfected for the detection and estimation of the addition of commercial glucose. This method is about ready for publication. A service and regulatory announcement has been issued relative to the use of second-hand containers (barrels) for sorghum sirup.

Probable date of completion.—1917.

Assignment.—S. F. Sherwood.

Proposed expenditures, 1916-17.—\$1,000.

Investigations in Cane-Sugar, Sirup, and Molasses Manufacture:

Object.—To obtain for analysis genuine samples of cane sirup from makers in various parts of the sugar-cane belt; to determine the influence of seasonal variations and of cane varieties on the composition of the product; to ascertain the effect of various methods of manufacture on the products; to study the use of new methods of clarifying and filtering cane sirup; and to determine the possible use of invertase and other inverting agents in preparing cane sirup which will not granulate or ferment.

Procedure.—As much of the experimental work as possible is carried out during the rather short cane-grinding season in the fall. Laboratory studies upon methods of inversion, clarification, and filtration are performed at Washington during the remainder of the year.

Cooperation.—Sirup makers in the sugar-cane belt; Office of Sugar Plant Investigations, Bureau of Plant Industry.

Location.—Washington, D. C., Cairo, Ga., and Franklin, La.

Date begun.—1914.

Results.—Field experiments were conducted at Cairo, Ga., Franklin, La., and at several points in Florida during the past year. By inverting part of the sucrose in the juices with invertase, sirups containing less than 25 per cent water were made which have not crystallized. The thicker boiling has also prevented fermentation. The effect upon the quality of the sirup of various factors, such as addition of acids, allowing cane to ferment partially before grinding, addition of fruit juices, method of boiling, etc., were investigated. The use of citric acid and grapefruit gave good results. Experiments on the clarification and filtration of the juices and sirups were carried out in the laboratory of the bureau. Experiments also were made on the manufacture of invertase, with the purpose of improving the method and decreasing the cost.

It can now be made at very small cost.

Probable date of completion.—1920.

Assignment.—C. S. Hudson, J. K. Dale, C. Wesley.

Proposed expenditures, 1916-17.—\$4,000 (paid from appropriation of the Bureau of Plant Industry for table-sirup investigations).

Investigation of the Composition of Vinegar Made from Cane and Sorghum Juices and of the Practicability of Making Such Vinegar on a Commercial Scale:

Object.—To find out whether a palatable vinegar can be made directly from cane and sorghum juices and, if so, to determine its composition; also to determine as nearly as practicable the commercial possibilities of the manufacture of vinegar from these sources.

Procedure.—As indicated under "Results."

Location.—Washington, D. C., and Cairo, Ga.

Date begun.—1915.

Results.—During the fiscal year 1916 the preliminary work of making several barrels of vinegar from cane juice by the slow barrel process was done at Cairo, Ga., one of the largest producing centers for cane sirup. The vinegar stock

Investigation of the Composition of Vinegar Made from Cane and Sorghum Juices and of the Practicability of Making Such Vinegar on a Commercial Scale—Continued.

prepared was left in a warehouse in Cairo under such conditions that it should go over into vinegar in due time. From observations made at Cairo it is believed that it is not practicable to make vinegar on a large commercial scale from cane or sorghum juice. The reasons for this conclusion will be given in the final report on this project. The work is being continued with a view to determine whether it is possible and practicable to make a vinegar in this way for local use in the home or on the farm.

Probable date of completion.—1917.

Assignment.—R. W. Balcom.

Proposed expenditures, 1916-17.—\$250.

Total, Carbohydrate Investigations, \$5,250.

INSECTICIDE AND FUNGICIDE INVESTIGATIONS.

(Destruction of Larvæ of the House Fly: Project completed. Borax and hellebore have both been found to be effective and practical larvicides, with no injurious action on the fertilizing value of the manure in which the house fly breeds. It is recommended that hellebore be used on manure which is to be employed as a fertilizer, and borax in privies, refuse piles, etc. Results published in Department Bulletins 118 and 245.)

Toxic Effect of Sprays on Fruit Trees through the Medium of the Soil:

Object.—To determine whether or not orchards can be injured by poisonous sprays acting through the medium of the soil and, if so, under what conditions this occurs and how to remedy it.

Procedure.—Samples of sprayed and unsprayed trees, which have or have not been treated with various poisonous spraying materials, and soils in which same are growing, are collected by the Bureau of Entomology, with complete history of the samples, and these samples are examined by the Bureau of Chemistry.

Cooperation.—Bureau of Entomology.

Location.—Washington, D. C.

Date begun.—1910.

Results.—Chemical work completed; data ready for collation, with the idea of publication as a bulletin. The significance of the results can not be determined until the data have been studied.

Probable date of completion.—1917.

Assignment.—J. K. Haywood, C. C. McDonnell, W. B. Pope.

Proposed expenditures, 1916-17.—\$300.

Foliage Injury by Lead Arsenate and Other Insecticides:

Object.—To determine what causes foliage injury in triplumbic arsenate; to determine the action of various impurities in lead arsenate on foliage; to discover spray mixtures which, while acting in an efficient manner as insecticides, will produce minimum injury to tender foliage.

Procedure.—Samples of known composition are prepared and subjected to test in the orchard, and the results observed.

Cooperation.—Bureau of Plant Industry.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1898.

Results.—It has been confirmed that diplumbic arsenate burns where triplumbic arsenate does not burn and that certain by-products found in the preparation of lead arsenate do not burn. Results of part of the work have been published in Bureau of Chemistry Bulletin 131, "Lead Arsenate." During 1916 the action of various solvents on diplumbic arsenate was studied. It was found that certain of such solvents which are present in the ordinary water act on diplumbic arsenate and set soluble arsenic free, thus resulting in a burning of the foliage. The results of this investigation were published in the American Journal of Science, vol. 42, No. 248, August, 1916, under the title "The Preparation and Properties of Lead Chlor Arsenate."

Assignment.—J. K. Haywood, C. C. McDonnell.

Proposed expenditures, 1916-17.—\$200.

Analysis of Insecticides and Fungicides:

Object.—To aid other bureaus of the department, especially the Bureau of Entomology, in solving problems which require chemical investigations of an insecticidal or fungicidal nature.

Procedure.—When other bureaus of the department meet insecticidal and fungicidal problems which require chemical investigation, the facts are submitted to the Bureau of Chemistry and the necessary investigations undertaken to solve such problems.

Cooperation.—Principally the Bureaus of Entomology and Plant Industry.

Location.—Washington, D. C.

Date begun.—1900.

Results.—Ascertained facts are transmitted to the bureaus interested. Results of certain of these investigations have been published as bulletins of the Bureau of Chemistry. Other results have been published in Bureau of Entomology bulletins. During the past two years an investigation for the Bureau of Entomology has been made of chemical problems in connection with fumigation with hydrocyanic-acid gas; as to the amount of arsenic in bees and parts of bees feeding on blossoms sprayed with arsenicals; in connection with the preparation of new tree-banding materials and the preparation of insecticide used against certain insects on cotton; and analyses have been made of a considerable number of insecticides. An investigation was made for the Bureau of Plant Industry of the copper content of tomato plants which had been fed with copper through the medium of the roots. In the past the following publications have been issued under this project: Bureau of Chemistry Bulletins 82, "Paris Green Spraying Experiments," and 131, "Lead Arsenate"; and Bureau of Entomology Bulletin 90, part 3, "The Chemistry of Fumigation with Hydrocyanic-Acid Gas."

During 1916 large quantities of a new tree-banding material were prepared, which will be tested out in the field during the coming season. Work on the fumigation of cotton bales with hydrocyanic-acid gas against the pink bollworm has been continued. Studies were made of the cyanid and arsenic content of plants treated with cyanids and arsenical compounds by inoculation and through the roots.

Assignment.—J. K. Haywood, C. C. McDonnell, F. C. Cook.

Proposed expenditures, 1916-17.—\$2,500.

Total, Insecticide and Fungicide Investigations, \$3,000.

FRUIT AND VEGETABLE UTILIZATION INVESTIGATIONS.**Potato Drying for Stock Feed:**

Object.—To prepare a high-grade stock feed from potatoes.

Procedure.—Potatoes are washed, ground, and pressed and the residue dried for stock feed. The by-products of this process are potato protein and potato juice.

Cooperation.—Office of Pomological and Horticultural Investigations, Bureau of Plant Industry.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1914.

Results.—A plant has been erected at the Arlington Farm of sufficient size to dry potatoes at the rate of one carload per day. The erection of this plant included, besides the necessary building, the installation of a 75-horsepower boiler with steam connections, electric power, potato washer, elevator, grinder, hydraulic press, and drier.

During 1916 it has been found possible to treat potatoes economically in this plant, converting them into dried pressed potato, which is a valuable carbohydrate feed. When ground and bolted, pressed potato flour is produced which is of value as a food for man and in the textile industry.

Probable date of completion.—Experimental work, January, 1917; extension work, consisting of erection and operation of demonstration plant in the field, to be undertaken if results warrant.

Assignment.—H. C. Gore.

Proposed expenditures, 1916-17.—\$3,185.

Manufacture and Utilization of Potato Starch:

Object.—To improve present methods of preparing potato starch in the United States and to increase its use in the arts and as a food.

Procedure.—Survey of present methods, followed by experiments to improve methods of manufacture of potato starch and methods of manufacture of dextrin and glucose from potato starch, and to extend the use of potato starch as food.

Manufacture and Utilization of Potato Starch—Continued.

Cooperation.—Office of Pomological and Horticultural Investigations, Bureau of Plant Industry.

Location.—Arlington Farm, Va.

Date begun.—January, 1916.

Results.—Work has not progressed sufficiently to report results at this time.

Assignment.—H. C. Gore.

Proposed expenditures, 1916-17.—\$1,500.

Potato Analyses:

Object.—To determine the composition of potato samples submitted by the Bureau of Plant Industry.

Procedure.—Usual laboratory methods of chemical analysis are followed.

Cooperation.—Office of Pomological and Horticultural Investigations, Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Several hundred analyses were made during the past year.

Assignment.—H. C. Gore.

Proposed expenditures, 1916-17.—\$600.

Preparation of Ensilage from Potatoes:

Object.—To develop an economical and practical method of preparing a cattle feed out of waste potatoes.

Procedure.—Potatoes are soured under experimental conditions in the laboratory, followed by the preparation of larger amounts, and ultimately experiments under actual farm conditions.

Cooperation.—Bureau of Animal Industry.

Location.—Washington, D. C., Beltsville, Md., and Arlington Farm, Va.

Date begun.—1915.

Results.—Potato silage has been produced in an experimental way with great success. The souring has followed approximately the same line as is found in corn silage, sauerkraut, and related products.

Probable date of completion.—June 30, 1917.

Assignment.—H. C. Gore, C. Thom, L. A. Round.

Proposed expenditures, 1916-17.—\$1,500.

Preparation of Cider Concentrated by Freezing:

Object.—To manufacture from apples, pure apple cider sufficiently stable to endure transportation without use of artificial preservatives.

Procedure.—The cider is frozen, crushed, and centrifugalized. The concentrated apple juice which is thus removed from the ice is then filtered.

Location.—Washington, D. C., and point in field to be determined.

Date begun.—1913.

Results.—Cider can be concentrated in this manner at a cost of less than 20 cents per gallon of the finished product. The finished product is sufficiently stable to endure transportation to market without the use of preservatives. During the past year a large plant for the production of this product has been started by private parties.

Probable date of completion.—Experimental work completed; demonstration work, now under way, should be completed by January, 1917.

Assignment.—H. C. Gore.

Proposed expenditures, 1916-17.—\$2,000.

(Manufacture of Sirup from Apples: Project completed. Field investigations have shown that an attractive sirup can be prepared from apples on a small scale or large scale, using simple equipment. In consequence of the comparatively high price of the raw material, the preparation of sirup on a manufacturing scale can not be advised, but sirup making from apples on a domestic scale for utilizing culls already available is practicable.)

Composition of Grape Juice:

Object.—To determine variations in composition from season to season of grapes of the eastern United States.

Procedure.—Preparation of grape juice and its analysis.

Cooperation.—Office of Pomological and Horticultural Investigations, Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1911.

Composition of Grape Juice—Continued.

Results.—Five years' work has been completed and the results reported to the viticulturist of the Bureau of Plant Industry to be used by him in a department publication. An article has also been published in the Journal of Industrial and Engineering Chemistry, April, 1916.

Probable date of completion.—December, 1916.

Assignment.—H. C. Gore.

Proposed expenditures, 1916-17.—\$200.

Determination of Food Value of Fruit and Vegetable Products:

Object.—To determine the merits as food of fruit and vegetable products.

Procedure.—The culinary quality and food use of fruit and vegetable products, such as sugar-beet sirup, cider concentrated by freezing, new fruit sirups, dried pressed potatoes, and potato starch will be tested.

Cooperation.—Office of Home Economics, States Relations Service.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Dried pressed potato flour has been tested and found to be of value, particularly as a pancake flour.

Assignment.—H. C. Gore, C. F. Langworthy.

Proposed expenditures, 1916-17.—\$200.

(Preparation of Fruit Flavors from Surplus Fruits: Project completed. The purpose was to determine the merit of fruit flavors prepared by concentrating the juice of the various fruits by freezing and then preserving by adding grain alcohol in the proportion of 1 part by volume to 10 parts by volume of the concentrated fruit juice. By this method the products are preserved indefinitely from spoilage through the growth of microorganisms. It was found, however, that it is less widely applicable to fruit juices than was at first supposed, as the most valuable fruit flavors, such as strawberry, pineapple, and red raspberry did not retain distinctive colors or flavors on keeping.)

Preparation of Sirup from Sugar Beets:

Object.—To develop a simple method for the preparation of sirup from sugar beets on the farm.

Procedure.—Sugar beets will be washed, sliced, treated with hot water to remove sugar and extract, and then slowly boiled down to a sirup.

Cooperation.—Sugar Plant Investigations, Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1914.

Results.—A sirup of excellent quality for cooking and table purposes can be easily prepared from sugar beets, but it is proposed to improve the product somewhat further in its color and flavor.

Probable date of completion.—January, 1917.

Assignment.—H. C. Gore.

Proposed expenditures, 1916-17.—\$200.

Total, Fruit and Vegetable Utilization Investigations, \$9,385, including \$1,050 statutory.

CATTLE-FOOD AND GRAIN INVESTIGATIONS.**Composition and Value of Range Forage Crops:**

Object.—To determine by analytical methods the composition and value of the forage crops growing naturally on the ranges of the arid and semiarid West.

Procedure.—Promising forage plants on ranges of the arid and semiarid West are collected by agents of the Bureau of Plant Industry and sent to Washington for analysis. The history and description of such samples are written by the Bureau of Plant Industry agent, and the combined results of the two bureaus, together with the average analysis of the same forage crops gathered by the Bureau of Chemistry, are published.

Cooperation.—Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1910.

Results.—The results of previous work are published in Department Bulletin 201, "Native Pasture Grasses of the United States." Data are now being obtained for two more bulletins on native forage crops, and previous analyses are being collated and new analyses made.

Assignment.—J. K. Haywood, G. L. Bidwell.

Probable expenditures, 1916-17.—\$500.

Utilization of Waste By-Products as Cattle Foods:

Object.—To utilize as cattle foods various materials which are now waste products.

Procedure.—Factories will be visited, the waste products studied chemically, and promising waste materials tested on cattle; also methods of preparing same in a form suitable for use will be studied.

Cooperation.—Bureau of Animal Industry and various manufacturers.

Location.—Washington, D. C.

Date begun.—1913.

Results.—A number of manufacturing plants have been visited to obtain information in regard to problems to be solved. A preliminary investigation of waste yeast from breweries has been started, the composition of the article determined, and methods of preparation investigated. During 1916 a method of preparing waste yeast as a cattle food was studied and decided upon. Large quantities of such waste yeast were prepared and are now being used in feeding tests.

Assignment.—J. K. Haywood, G. L. Bidwell.

Proposed expenditures, 1916-17.—\$1,000.

Analyses of Cattle Foods and Grains:

Object.—To aid other bureaus of the department in solving problems in which the composition of cattle foods and grains is a factor.

Procedure.—Other bureaus carrying on cattle-food and grain investigations submit samples to the Bureau of Chemistry, which are examined.

Cooperation.—Bureau of Plant Industry and other bureaus of the department.

Location.—Washington, D. C.

Date begun.—1904.

Results.—About 200 samples were examined during 1916. Between 200 and 300 samples are examined each year.

Assignment.—G. L. Bidwell.

Proposed expenditures, 1916-17.—\$1,000.

Total, Cattle-Food and Grain Investigations, \$2,500, including \$300 statutory.

ISOLATION AND STUDY OF COMPOUNDS FROM THE COTTON PLANT, GOSSYPIUM HERBACEUM.**Isolation and Study of Compounds from the Cotton Plant, Gossypium Herbaceum:**

Object.—To study the chemotropism of the cotton-boll weevil.

Procedure.—Various compounds are isolated from the cotton plant. These compounds are to be used by the Bureau of Entomology to study the chemotropism of the boll weevil. If it is found that the weevil is attracted to the cotton plant by some definite compound, this knowledge is to be used in fighting the pest. The work will be carried on during the summer months on the growing cotton plant. If results warrant, the work will be continued from year to year.

Cooperation.—Bureau of Entomology.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Among other substances an ethereal oil which seems to be attractive to boll weevils has been isolated. Since the steam distillate containing it proved to be attractive to boll weevils, it will be isolated in greater amount and tried during the coming season. The glucoside, quercimeritrin, has been isolated not only from the petals but also for the first time from the calyces and leaves. A paper entitled "On the Distribution of Quercimeritrin in the Cotton Plant" was read at the December, 1915, meeting of the Society of Biological Chemists, a report of which was published in the Journal of Biological Chemistry, 1916, vol. 24.

Assignment.—A. Viehoveer, C. O. Johns, L. H. Chernoff.

Proposed expenditures, 1916-17.—\$500.

Total, Investigations in Agricultural Chemistry, \$54,890, including \$6,090 statutory. This total includes \$4,700 for emergencies and new projects.

COLLABORATION WITH OTHER DEPARTMENTS.

[Regulation.]

Tests for Post Office Department:

Object.—To conduct such investigations and make such analyses of foods, drugs, or other materials transported through the United States mails as the Post Office Department may request, with a view to prevent the use of the mails for fraudulent purposes.

Procedure.—Samples of the above-mentioned products as submitted by the Post Office Department will be analyzed by the usual laboratory methods. In cases where no official methods of analysis have been adopted it may be necessary to develop methods. The work, on the whole, consists of the chemical analysis of food and drug products as submitted by the Post Office Department.

Cooperation.—Post Office Department and Department of Justice.

Location.—Washington, D. C.

Date begun.—About 1904.

Results.—As a result of the analyses made and reported, the Post Office Department has prohibited the shipment through the mails of a number of fraudulent medicines.

Assignment.—C. L. Alsberg, L. F. Kebler.

Proposed expenditures, 1916-17.—\$2,000.

Testing Contract Supplies:

Object.—To determine the proper specifications for certain Government contract supplies and to determine whether the goods delivered comply with the specifications.

Procedure.—Chemical or physical laboratory tests are made of the samples according to official methods of analysis. Only such materials are examined as foods, drugs, and other articles that come within the scope of the work of this bureau and that, therefore, can not so readily be handled by other offices of the Government.

Cooperation.—Departments of the Government and the General Supply Committee.

Location.—Washington, D. C.

Date begun.—1900.

Results.—Specifications have been developed for a large number of items and economies effected by requiring deliveries to conform to specifications. Assistance has been rendered the General Supply Committee in determining the quality of samples submitted with bids.

Assignment.—I. K. Phelps, F. P. Veitch, L. F. Kebler, C. S. Hudson.

Proposed expenditures, 1916-17.—\$2,500.

Miscellaneous Tests for Other Departments:

Object.—To assist in classifying various products under the tariff act, and to make chemical analyses for other departments when requested to do so.

Procedure.—Samples as submitted by the Treasury or other executive departments are analyzed according to official methods. When no official methods of analysis are available suitable methods are devised.

Cooperation.—Treasury and other departments.

Location.—Washington, D. C., and bureau branch laboratories.

Date begun.—1900.

Results.—A large number of chemical analyses have been made for and reported to other departments.

Assignment.—R. L. Emerson.

Proposed expenditures, 1916-17.—\$2,120.

[Research.]

Study of Cereal Dusts in Relation to Thresher, Mill, and Elevator Explosions:

Object.—To study the physical and chemical properties of grain and cereal dusts which occur in the threshing, storing, handling, and milling of wheat and other cereals, in order to determine the cause of explosions in threshers, mills, and elevators and to secure knowledge which will lead to the prevention of such explosions.

Procedure.—Special investigations are being carried on to determine the cause and methods of prevention of explosions in threshing machines in the Pacific Northwest. Samples of flour and other cereal dusts as found in threshing, in

Study of Cereal Dusts in Relation to Thresher, Mill, and Elevator Explosions—Continued.

grain elevators, and in mills are collected, and a complete study of their chemical composition and physical properties is made. In addition, the operations of threshing, storing, and milling wheat and other cereals are investigated and the efficiency of various types of milling equipment studied.

Cooperation.—Bureau of Mines, Department of the Interior; Office of Public Roads and Rural Engineering; Offices of Grain Standardization and Cereal Investigations, Bureau of Plant Industry; and Pennsylvania State College.

Location.—Washington, D. C., and Pittsburgh, Pa.

Date begun.—1914.

Results.—As a result of the investigations in the Pacific Northwest during the 1915 season, devices are being developed to prevent smut-dust explosions in threshing machines and grain fire losses. An automatic fire extinguisher has been constructed and successfully tested on threshing machines at the Arlington Farm, Va., and detailed drawings of the device were furnished the various manufacturers. A description of this device, together with an account of the investigations, has been published in Department Bulletin 379. Considerable data have been collected regarding grain-dust explosions in mills and elevators, and preliminary recommendations have been made for their prevention. A laboratory method has been developed for determining the relative inflammability of various dusts, and many types have been tested. The use of inert gas in grinding machines has been recommended as the result of laboratory tests. Considerable progress has been made in developing methods of analysis and constructing apparatus to be used in the tests. Apparatus is being developed in which it will be possible to use various means of ignition while different amounts of dust are held in suspension.

Probable date of completion.—1918.

Assignment.—G. A. Hulett and J. K. Clement, representing the Bureau of Mines, and D. J. Price and H. H. Brown, representing the Bureau of Chemistry.

Proposed expenditures, 1916-17.—\$8,000.

Investigations of Distinctive Papers:

Object.—To devise currency paper very difficult to counterfeit; to give more individuality to bills of different denominations, in order to make bill "raising" more difficult; and to increase the serviceability of currency paper.

Procedure.—Confidential; not to the best interests of the Treasury Department to make public.

Cooperation.—Bureau of Engraving and Printing, Bureau of Standards, paper makers, currency engravers and printers, and bankers.

Location.—Headquarters, Washington, D. C.

Date begun.—1913.

Results.—The first report to the Secretary of the Treasury, November 7, 1913, recommended distinctive portrait, design, and color of bills of each denomination. A reduction of \$12,500 per year in the cost of currency paper was also effected. Work is in progress on a practicable watermark, with indications of successful results.

Probable date of completion.—July, 1917 (continuing at the request of the Secretary of the Treasury).

Assignment.—Committee on distinctive paper: F. P. Veitch and C. F. Sammet, Bureau of Chemistry, and F. C. Clark, Bureau of Standards.

Proposed expenditures, 1916-17.—\$500.

Total, Collaboration with Other Departments, \$15,120 (regulation, \$6,620; research, \$8,500).

[Regulation.]

TESTING EXPORT FOOD PRODUCTS.**Testing Export Food Products:**

Object.—To inspect and test food products intended for export to foreign countries, for the purpose of determining whether the goods will meet the requirements of the country to which consigned.

Procedure.—Samples are taken from shipments for export. The samples are subjected to the same tests as those required by the country to which shipped. The cost of examination is paid by the exporter, the fees being turned into the miscellaneous receipts of the United States Treasury.

Testing Export Food Products—Continued.

Location.—Washington, D. C., New York, San Francisco, and other branch laboratories.

Date begun.—1904.

Results.—All samples submitted have been analyzed and certificates of tests furnished.

Assignment.—W. G. Campbell, L. M. Tolman, B. R. Hart.

Proposed expenditures, 1916-17.—\$4,280.

[Research.]

POULTRY AND EGG INVESTIGATIONS.**Poultry and Egg Research Work; General Laboratory Investigations:**

Object.—To discover fundamental scientific facts bearing on the preservation of quality and the prevention of decay of poultry and eggs and their products.

Procedure.—Laboratory analyses are made and experimental studies conducted in the laboratory and in industrial environment on both a laboratory and a commercial scale. Investigations of the effects of various methods of preserving eggs and poultry are undertaken and laboratory and other methods devised by which researches can be carried on. New lines of work are originated and carried to the point of independent projects. An extensive correspondence is conducted with producers, middlemen, and carriers on subjects connected with the investigations.

Cooperation.—Egg and poultry industry, warehousemen, and carriers.

Location.—Laboratories at Philadelphia, Pa., and Indianapolis, Ind.

Date begun.—About 1907.

Results.—(1) During 1916: A modification of the method of Folin for determinations of nitrogen enables the making of 70 determinations in a day as compared with 20 heretofore. Some valuable and entirely new data have been obtained on the greening of chicken flesh in decomposition. An ice-chilled precooling box for the use of small shippers which can be installed for about \$800 has been developed. Marked progress has been made in the development of poultry and egg packing-house construction and equipment.

(2) Prior to 1916: Laboratory procedures in chemistry and bacteriology have been adapted to the study of poultry flesh and eggs. New methods have been developed. Practical application of scientific facts to industrial problems has been made, with great improvement in commercial practices, as is evidenced by the gain in quality of such products on the market as cold-stored poultry and eggs. The accuracy of packing-house methods of chilling poultry, maintenance of sound and clean skins on the dressed birds, better appreciation of the importance of dry chilling and similar fundamentals, now quite generally understood and in common use, are referable, primarily, to the work of this project. Valuable information has been obtained on the growth of bacteria at low temperatures.

Assignment.—Mary E. Pennington, N. Hendrickson.

Proposed expenditures, 1916-17.—\$15,460.

Investigations of Poultry and Eggs during Transportation:

Object.—To determine the effect of conditions on the keeping quality of poultry and eggs during and subsequent to transportation.

Procedure.—Goods are prepared for shipment under exact methods of handling, including a knowledge of their condition as determined by laboratory analyses and inspection. Shipment is made under definite conditions, which are observed and recorded, and their effect upon the product is determined on arrival and during marketing by laboratory methods and inspection.

Cooperation.—Poultry and egg buyers, shippers, receivers, warehousemen, carriers, and refrigerator-car lines.

Location.—Poultry and egg producing territory from Texas to Minnesota and east and west coast cities.

Date begun.—1909.

Results.—(1) During 1916: Valuable modifications in apparatus for registering temperature changes during transit have been made. Transit temperature records of poultry pre-cooled in Department of Agriculture ice-pre-cooling plant were obtained during long hauls to market.

(2) Prior to 1916: Information concerning the preparation of poultry and eggs for shipment has been obtained. The temperatures maintained during

Investigations of Poultry and Eggs during Transportation—Continued.

transit and their effect on the product have been recorded and discussed in Bureau of Chemistry Circular 64, "Studies of Poultry From the Farm to the Consumer," and in Department Bulletin 17, "The Refrigeration of Dressed Poultry in Transit." Additional information on "wet-packed" dressed poultry in transit, precooled eggs in transit, cooling eggs during transit, and similar problems are affording valuable data, which both shippers and railroads are utilizing to decrease waste and decay.

Assignment.—Mary E. Pennington, H. A. McAleer, A. D. Greenlee.

Proposed expenditures, 1916-17.—\$500.

Breakage of Eggs in Transit:

Object.—To determine the cause of breakage, to fix responsibility, and to devise, test, and demonstrate methods by which damage in transit can be decreased.

Procedure.—Study is made of egg grading, egg packages, and stowing of loads in shipping sections; of conditions during transit on railroads and in trucks or wagons; of details of handling at terminals, on docks, and in warehouses; and of handling by receivers.

Cooperation.—Office of Markets and Rural Organization; National Poultry, Butter, and Egg Association; shippers, railroads, egg-package industry, receivers, and warehousemen.

Location.—Middle West, and east-coast cities.

Date begun.—1913.

Results.—(1) During 1916: Studies in the producing districts have shown that breakage between the hen and the country store is about 4 per cent; between the country store and the shipper by wagon, 2.3 per cent; and by local freight, 4 per cent; making a total in the producing section of 8 per cent of all eggs receiving shell damage. Better packing and handling of eggs have enormously reduced the damage to shells, as is evidenced in New York City, where, in 1914, 6.8 per cent of all cases received showed damage and in 1915 only 3.3 per cent showed damage.

(2) Prior to 1916: Approximately 150 experimental shipments were made, in car lots, of eggs packed in well-made standard cases with "medium" or heavier fillers and flats, so stowed in the car that the bracing and buffing absolutely prevented the shifting of the load. With reasonable care to avoid railroad shocks, especially in yard switching, it was shown that transit damage could be kept down to less than 2 per cent. The industry and the carriers have so modified their practices that breakage in transit is much lessened. For instance, during 1913, 20 per cent of the cases of eggs coming into New York showed damage, while during 1915 only 3.3 per cent showed damage. This improvement is referable directly to the campaign for better handling. Most of the transit damage now is found in less-than-car-lot shipments.

Probable date of completion.—1917.

Assignment.—Mary E. Pennington, H. A. McAleer, A. D. Greenlee.

Proposed expenditures, 1916-17.—\$5,000.

Egg Preservation by Refrigeration, Including Frozen and Dried Eggs:

Object.—To determine the fitness of certain eggs as food and to study their handling before and after refrigerated storage in the shell, freezing, and drying, and their use by the general consumer, bakers, and others, in order to save waste and improve quality.

Procedure.—Work is conducted in the laboratory, in packing houses, warehouses, and egg-breaking plants on the grading of eggs before the candle and out of the shell and on their handling, freezing, drying, and storage. Examination is made of the products in the market and in bakeries when subjected to commercial routine handling.

Cooperation.—Office of Markets and Rural Organization, egg-breaking establishments, bakers, egg shippers and receivers, railroads, and cold-storage warehousemen.

Location.—East-coast cities and egg-producing sections in the Middle West.

Date begun.—1911.

Results.—(1) During 1916: Information on the relative keeping quality under refrigeration of sound and cracked eggs, both fresh and of lowered grade, has been gathered. Study is being continued. Preliminary data have been obtained on the effect of packages in successful storage, on the rate of evaporation, the effect of shell cleanliness on keeping, and other fundamentals. The relative keeping quality of eggs refrigerated in the shell and hard frozen or dried has been ascertained.

Egg Preservation by Refrigeration, Including Frozen and Dried Eggs—Con.

(2) Prior to 1916: Pioneer information has been obtained on the effect of refrigeration on the composition and quality of eggs, both frozen and chilled. This has been published in Bureau of Chemistry Circular 64, "Studies of Poultry from the Farm to the Consumer," and in articles in scientific journals. Bureau of Chemistry Circular 98, "The Preparation of Frozen and Dried Eggs," and Department Bulletins 51, "A Bacteriological and Chemical Study of Commercial Eggs in the Producing Districts of the Central West," and 224, "A Study of the Preparation of Frozen and Dried Eggs in the Producing Section," give some of the results as applied to eggs preserved by refrigeration, freezing, and drying. Accurate data on egg preservation at temperatures above freezing are being applied by warehousemen and others to maintain quality. Articles in the Weekly News Letter of the department enable the industry to apply the information as soon as it becomes available. For example, see "Weekly News Letter," vol. 3, No. 32, "Loss in Cracked Eggs."

Assignment.—Mary E. Pennington, M. K. Jenkins, N. Hendrickson.

Proposed expenditures, 1916-17.—\$4,000.

Poultry Fleshing:

Object.—To study the behavior during killing, picking, chilling, packing, transporting, storing, and passage through the market of poultry fed after receipt by the packer for increase in weight and quality; and to determine the effect of different foods on the poultry during such preparation for market, in the packing house, and during its subsequent journey to the consumer, and the effect of such feeding on its palatability and nutritive value to the consumer.

Procedure.—Types of birds suited to feeding are differentiated from incoming stock and those birds discarded which can not be successfully used in experiments to determine caloric values, digestive coefficients, growth acceleration, specialized tissue formers, and such other information as may be necessary concerning the exact composition and effect of rations on poultry fed under the conditions and for the purposes stated. The investigations will include a study of methods of administering rations to determine the effect of quantities and frequency of feeding on the quality and composition of flesh; construction or development of quarters and appliances required for the commercial feeding of poultry in large numbers and in the unnatural environment of the packing house in order to procure a flesh of exact and constant composition; determination of the best methods of emptying the intestinal tract during the 24 hours preceding slaughter with a minimum loss of flesh; invention or development of special appliances and methods for the killing, bleeding, picking, chilling, and packing of the brittle-boned, tender-skinned, soft-meated birds resulting from heavy feeding in captivity; determination of the effect of transportation temperatures, holding-room temperatures, long-freezer storage, window displays, and the routine of marketing on the stability of the flesh of the dressed bird; and a study of the character of the changes undergone.

Cooperation.—Bureau of Animal Industry, Office of Markets and Rural Organization, poultry packers having feeding stations, railroads, carriers in general, warehousemen, commercial men, jobbers, and retailers. (Nutrition experiments in the Bureau of Chemistry.)

Location.—Poultry-packing houses in the Middle West, east-coast cities, and bureau laboratories at Indianapolis and Philadelphia.

Date begun.—1915.

Results.—Work is well under way on a few definite rations which have been selected from a large number of trial rations. Some data on the amount of food required to produce a pound of chicken, the relation between weight gained and food consumed, and the distribution of fat in the carcass have been obtained. The work has consisted very largely of the analysis of feeding stuffs and the securing of general scientific information bearing on the problem.

Assignment.—Mary E. Pennington, H. A. McAleer, A. D. Greenlee, A. W. Broomell.

Proposed expenditures, 1916-17.—\$4,500.

Instructing Shippers, Carriers, and Others in Handling Poultry and Eggs:

Object.—To disseminate by personal contact, demonstrations, publications, etc., information obtained through investigation on the principles of handling eggs and dressed poultry, and to confirm the practicability of such principles when applied on a large scale.

Instructing Shippers, Carriers, and Others in Handling Poultry and Eggs—Continued.

Procedure.—Meetings are held at shipping and receiving points, presided over by investigators, to which all the industry, the railroad agents, etc., are invited. Visits are made to shippers, receivers, warehousemen, etc., to observe methods in use and obtain and give general information; also trips with a demonstration car carrying a refrigerator plant. Practical demonstrations are given of the application of better methods in houses of cooperating packers, and packers are assisted in building and equipping economical and efficient poultry and egg-packing houses.

Cooperation.—Office of Markets and Rural Organization, buyers, shippers, railroads, warehouses, receivers of poultry and eggs, and State agricultural colleges.

Location.—Indiana, Illinois, Ohio, Kentucky, and east-coast cities, and occasionally minor activities in producing sections in other States.

Date begun.—About 1910.

Results.—(1) During 1916: A very marked gain in interest in refrigeration for egg and poultry packing houses and in the installation of refrigeration, either mechanical or the Department of Agriculture ice-precooling plant, has taken place in a large number of establishments during the past year. A marked improvement has occurred in handling eggs, as evidenced by lessened breakage, better grading, and wider candling. Improvement in refrigerated transportation service has been noted, as well as increased interest on the part of railroad companies and refrigerator-car lines in the handling of refrigerated freight.

(2) Prior to 1916: The scientific information obtained in the investigations has been put into practice in the industry through the practical personal contact of the investigators. This is evidenced by the great improvement in poultry and egg packing houses and the appliances used in them and in their killing, picking, packing, and general handling routine. It is also seen in the increased interest in better methods and efforts in the line of conservation. County agents, railroad dairy freight agents, commercial poultry supply salesmen, refrigerator supply men, engineers, refrigerator-car builders, and many others whose interests touch poultry and egg handling have been supplied with information which they disseminate, thereby extending its usefulness.

Assignment.—Mary E. Pennington, H. A. McAleer, H. C. Pierce, A. D. Greenlee, H. L. Shrader, E. C. Heinsohn, H. C. Albin.

Proposed expenditures, 1916-17.—\$10,540.

Total, Poultry and Egg Investigations, \$42,500, including \$2,500 statutory.

[Research.]

FISH INVESTIGATIONS.

Freezing and Cold Storage of Fish:

Object.—To study present practices in handling fish for freezer storage, with a view to the prevention of loss through deterioration.

Procedure.—Chemical, bacteriological, and histological studies are made of the effects of low temperature and different periods of storage upon fish handled in the commercial way. Trade practices in glazing, gutting, and wrapping fish for storage as a means of preservation are investigated. It is planned to devise new scientific methods, if necessary, for detecting changes in fish during storage and for the detection of spoilage.

Cooperation.—Fishermen, dealers, and fish freezers.

Location.—Philadelphia, New York, and fish-producing points.

Date begun.—1914.

Results.—Extensive experiments involving long periods of freezer storage on fish treated in various commercial ways are in progress. These experiments must be repeated several years in succession for confirmation. New chemical methods have been devised to detect incipient deterioration in fish and similar products, and these methods have been successfully applied to the study of oysters and fish under refrigeration.

Assignment.—Mary E. Pennington, E. D. Clark, L. H. Almy.

Proposed expenditures, 1916-17.—\$3,470.

Transportation and Handling of Fish:

Object.—To investigate present methods of handling, packing, and shipping fish, in order to devise ways of improving the quality and preventing loss.

Procedure.—Chemical and other methods are used in studying the efficiency of present handling and shipping practices in conserving the quality of fish.

Transportation and Handling of Fish—Continued.

Experimental shipments of fish are made and modes of handling studied, with the view of improving the quality of fish shipped under present methods and also under any new methods which may be proposed.

Cooperation.—Carriers, refrigerator-car lines, and fish dealers.

Location.—Fish-producing and consuming centers and their shipping connections in the eastern, middle-western, and Pacific-coast districts.

Date begun.—1915.

Results.—Field and laboratory studies have been made of commercial methods of handling and transporting fresh shrimp. The adoption of better handling has given a great impetus to the shrimp industry. Complete chemical and temperature data have been obtained for the first time on car lots of fish in transit from Florida to New York City.

Assignment.—Mary E. Pennington, E. D. Clark.

Proposed expenditures, 1916-17.—\$6,890.

Systematic Food Analysis of Fish:

Object.—To conduct chemical analyses of all available food fishes to determine their food value and variations in composition.

Procedure.—Complete analyses of all available species of fish from the point of view of their food value are made and compiled. The seasonal, physiological, and local variations in the chemical composition of fish are ascertained and the constants of their different food components determined.

Cooperation.—Fish producers and dealers.

Location.—Philadelphia and field laboratories.

Date begun.—1914.

Results.—Complete analyses of many species of food fish have been made and compiled, which show that the analytical tables already published are very inaccurate, because the fish were not analyzed at different seasons and the yearly average obtained. A tabulation of these results is under way and should prove of considerable value to all later investigators on the composition of American food fishes.

Assignment.—Mary E. Pennington, E. D. Clark, L. H. Almy.

Proposed expenditures, 1916-17.—\$2,870.

Fish By-Products and New Sea Foods:

Object.—To investigate the utilization of fish waste products and new foods from fish, shellfish, and their commercial products.

Procedure.—Chemical and other methods are followed in the laboratory and field for the study and development of commercial uses for fish oils, glue, gelatin, waste, etc. New uses for fish and fish products as foods or for other purposes will be developed after chemical study and practical work with the fish industries.

Cooperation.—Bureau of Fisheries, fish dealers, and fish by-product industry.

Location.—Headquarters, Philadelphia, Pa.; bureau laboratories and fish-producing points on the east and west coasts.

Date begun.—1915.

Results.—The chemical constants and viscosities of the oils of many species of fish have been determined and tabulated. Survey data have been obtained preliminary to the conduct of work on the properties and value of salmon oils for industrial uses.

Assignment.—Mary E. Pennington, E. D. Clark.

Proposed expenditures, 1916-17.—\$1,970.

Total, Fish Investigations, \$15,200, including \$1,200 statutory.

[Research.]

OYSTER AND OTHER SHELLFISH INVESTIGATIONS.**Investigations Regarding the Sanitary Inspection of Shellfish Areas and the Handling and Shipping of Shellfish:**

Object.—To obtain information looking toward the improvement of the sanitary quality of shellfish reaching the market.

Procedure.—The work includes a sanitary survey of oyster and clam beds and studies of shellfish in the various stages of marketing.

Cooperation.—Hygienic laboratory, State shellfish commissions, and State boards of health.

Location.—Headquarters, Washington, D. C.; field laboratories are established in locations favorable to the study of the shellfish industry.

Investigations Regarding the Sanitary Inspection of Shellfish Areas and the Handling and Shipping of Shellfish—Continued.

Date begun.—1913.

Results.—New areas have been surveyed and mapped in the vicinity of New York, Connecticut, and Rhode Island waters, and the sale of shellfish from certain polluted waters has been checked.

Assignment.—P. B. Parsons.

Proposed expenditures, 1916-17.—\$4,000.

Investigations Regarding the Conservation of the By-Products of the Oyster Industry:

Object.—To secure data relative to the waste of the by-products of the oyster industry, with a view to ascertain whether the same can be utilized on a commercial scale.

Procedure.—Information will be gathered in connection with the other investigational projects on the handling of oysters.

Cooperation.—Oyster Growers' and Dealers' Association of North America.

Location.—Headquarters at Washington, D. C.; temporary laboratories established in connection with the handling of oysters.

Date begun.—1914.

Results.—No work has been possible on this project during the past year.

Assignment.—P. B. Parsons.

Proposed expenditures, 1916-17.—\$1,000.

Total, Oyster and Other Shellfish Investigations, \$5,000.

[Research.]

BIOLOGICAL INVESTIGATIONS OF FOOD AND DRUG PRODUCTS.

Chemical Investigations of Vegetable Proteins:

Object.—To determine the chemical composition of proteins as a basis for ascertaining their food value; to investigate the hitherto unknown nitrogenous constituents of seeds and plants; to examine seeds and plants which are at present not used for foods, to ascertain whether these contain compounds which might be used to supplement the deficiency of other foods; and to develop analytical methods for the estimation of proteins in seeds.

Procedure.—Isolation and hydrolysis of proteins from seeds and plants and a study of the composition and properties of such proteins.

Location.—Washington, D. C.

Date begun.—1915.

Results.—A study of the proteins of the jack bean, *Canavalia ensiformis*, has been made. Three proteins have been isolated, namely, two globulins and an albumin. A preliminary report of this work was made at the meeting of the Society of Biological Chemists, at Boston, December, 1915. A more complete paper was presented at a meeting of the American Chemical Society, at Urbana, Ill., April, 1916. Work on the proteins of kafir corn, *Andropogon sorghum*, has been started.

It has been shown that more than half of the nitrogenous compounds of kafir corn are soluble in warm alcohol. The solution consists chiefly of an alcohol-soluble protein. This protein contains lysine and tryptophane, which must both be present in a protein to produce growth when used for feeding. Both lysine and tryptophane are lacking in zein, the alcohol-soluble protein of maize. A paper on this work was presented at the Urbana meeting of the American Chemical Society, April, 1916. A method for estimating the alcohol-soluble protein of kafir corn has been developed.

Assignment.—C. O. Johns, D. B. Jones.

Proposed expenditures, 1916-17.—\$8,700.

Nitrogen Distribution in Various Cereals and Other Feeding Stuffs:

Object.—To determine the nature and amount of certain of the amino acids of which the mixed proteins of seeds are composed without previously isolating the proteins themselves, and to analyze by the Van Slyke method the isolated proteins of seeds and feedstuffs.

Procedure.—The various seeds and proteins are hydrolyzed with dilute mineral acid, which liberates the amino acids. These are determined by the method of Van Slyke.

Location.—Washington, D. C.

Date begun.—1914.

Nitrogen Distribution in Various Cereals and Other Feeding Stuff— Continued.

Results.—During the past year nitrogen distribution has been determined in wheat, cowpeas, jack beans, an isolated protein of kafir corn, and in nucleic acid. The analysis of cowpeas indicated a very high content of the amino acid, arginine (arginine nitrogen, 17.68 per cent of the total nitrogen). The jack beans appear to have a very good nitrogen distribution in the so-called hexone bases. In the analysis of the kafir protein, histidine nitrogen was found to be 1.64 per cent of the total nitrogen. This is in contradiction to the results of the analysis of whole kafir grain, in which no histidine nitrogen could be found. The analysis of nucleic acid shows that this complex nitrogenous substance, which is always present in the germ of seeds, can be regarded as a source of error in applying the Van Slyke method to the analysis of whole-seed material.

Assignment.—J. F. Brewster.

Proposed expenditures, 1916-17.—\$500.

Effect upon Health of Feeding Small Quantities of Saponins for Long Periods:

Object.—For some years saponins have been used in various food products, notably in soft drinks for the purpose of making them foam. "Saponin" is a term covering a wide range of compounds, many of which are extremely poisonous and all of which possess the power in very great dilution of dissolving red blood corpuscles. The use of certain saponins in food products is undoubtedly objectionable. Whether others less toxic are permissible is open to question. All the experimental work with saponins hitherto recorded has been done with large doses, so that no conclusions can be drawn which are of value in guiding this bureau in the enforcement of the food and drugs act. In the proposed experiments small dosages, comparable with those in foods, will be employed in order to see whether evidence may be gathered that can be used to support action against the use of saponins. An effort will be made to determine whether the toxicity of different saponins as measured by their hemolytic power has any relation to the surface tension of the concentration that causes hemolysis. The results should be of value in the estimation of saponins in food.

Procedure.—Inasmuch as the feeding of small quantities of saponins to animals over long periods is often without visible effect, and inasmuch as the chief toxic action of saponins is on red blood corpuscles, it is proposed to feed animals for long periods with small quantities of saponins and then examine the resistance of their red corpuscles to laking.

Location.—Washington, D. C.

Date begun.—1914.

Results.—The surface tension of solutions of about 10 saponins have been measured and the concentrations that cause hemolysis determined. There is a great difference in hemolytic activity, some saponins causing hemolysis in concentrations of 5 parts per million and others only in concentrations of several thousand parts per million. The surface tension of water is reduced by 10 to 20 per cent by saponins when present in a concentration of 100 parts per million. There appears to be no relation between the hemolytic activity and the surface tension of saponin solutions. The results thus far obtained indicate that there is a distinct effect upon the red corpuscles, which is more marked in some cases than in others.

Probable date of completion.—1917.

Assignment.—C. L. Alsberg, H. E. Woodward.

Proposed expenditures, 1916-17.—\$500.

Utilization of Hydrogenated Oil:

Object.—To determine whether certain hydrogenated oils can safely be used as edible fat or lard substitutes. The results will determine the action of the bureau under the food and drugs act.

Procedure.—Pure whale oil will be fed to experimental animals and the fate of the fat absorbed determined.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Work on this project will probably be completed this fiscal year and the results published.

Probable date of completion.—1917.

Assignment.—C. L. Alsberg, C. S. Smith.

Proposed expenditures, 1916-17.—\$300.

Total, Biological Investigations of Food and Drug Products, \$10,000.

[Research.]

CITRUS BY-PRODUCTS INVESTIGATIONS.

Citrus By-Products Investigations:

Object.—To devise commercial methods for the utilization of cull citrus fruits.

Procedure.—These investigations include studies of devices for separating essential oils from the peel, with a view to increase the quantity and quality of the product; the development of methods for increasing the yield of juice obtained from citrus fruits and the improvement of present methods for its clarification; determination of methods for the decomposition of citrate of lime and the clarification and crystallization of citric-acid solutions for the elimination of heavy metals from citric acid solution, including a search for resistant alloys and enamels, and for the manufacture of vinegar from orange juice. The possibility of producing a commercial marmalade stock by evaporation of ground oranges *in vacuo* and of producing a substitute for apple-base pectin from orange and lemon peel is also being studied, as well as the relative oil and citric-acid content of lemons at different times of the year and in different localities.

Besides continuing the investigations above indicated, studies will be inaugurated having in view the determination of the possibility of concentrating citrus-fruit juices by freezing and ascertaining the proper methods for keeping the concentrated products thus obtained. A study of the manufacture and concentration of distilled oil from residual orange and lemon peel and the preparation of dried peel will also be undertaken, as well as an investigation of the handling of cull fruit from the grove to the by-product factory and of methods of packing and marketing citrus by-products.

Location.—Los Angeles, Cal.

Date begun.—1911.

Results.—The work on the manufacture of citrate of lime is completed. Both the quantity and the quality of the product have been increased and bettered as a result of the application of methods developed through these investigations. The citric acid study is from 50 to 60 per cent completed. The work on the elimination of heavy metals and the search for resistant alloys is being pushed. Methods of crystallization are being studied with a view to shorten the process.

Devices for the extraction of essential oils have been tried and discarded. New schemes which eliminate the defects of former methods are now planned. These studies are not more than half completed. The study of the manufacture of vinegar from orange juice is completed. A satisfactory product can be readily made, but the competition with low-grade vinegars will limit its consumption.

A beginning has been made on the problem of marmalade stock and as soon as the best methods of treatment have been discovered samples of the product will be submitted to practical manufacturers for experimental purposes. Preliminary studies have been made on the production of pectin from citrus peel, work having been confined to treatments for the elimination of the undesirable bitter flavor.

Probable date of completion.—1918.

Assignment.—E. M. Chace, C. P. Wilson.

Proposed expenditures, 1916-17.—\$8,920, including \$840 statutory.

[Research.]

COLOR INVESTIGATIONS.

Investigation of Color Substances:

Object.—To investigate the formation of color substances from raw materials, principally of American origin. Problems in plant physiology and plant production will not be undertaken except through cooperation with the Bureau of Plant Industry. A considerable portion of the work will deal with equilibria reactions for the purpose of investigating conditions of formation and yields.

Procedure.—It is proposed to install technical apparatus on a manufacturing scale at the Arlington Farm, since many chemical reactions which are successfully carried out on a laboratory scale require many modifications and changes in conditions to meet technical and manufacturing requirements.

Cooperation.—None at present arranged. It is contemplated that cooperation will be arranged with other bureaus and departments of the Government wherever this seems advisable.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—July, 1916.

Assignment.—H. D. Gibbs.

Proposed expenditures, 1916-17.—\$51,800, including \$1,800 statutory.

ENFORCEMENT OF THE FOOD AND DRUGS ACT.

[Regulation.]

ADMINISTRATION.

Collaboration with State Officials:

Object.—To secure collaboration with State food, drug, dairy, and feeding-stuffs officials in order more efficiently to enforce the food and drugs act.

Procedure.—This project involves the collection and dissemination of information relating to methods of analysis, definitions, standards, and administrative problems.

Cooperation.—Food, drug, dairy, and feeding-stuffs officials of various States and cities.

Location.—Washington, D. C.

Date begun.—1907.

Results.—A practical and effective system of cooperation between State and Federal officials in the enforcement of food, drug, and feeding-stuffs laws has been established. Important investigational data relating to methods of analysis and the proper basis for judging the purity and quality of food and drug products have been exchanged with State officials. A plan has been worked out whereby State officials are assisting in the enforcement of the Federal food and drugs act by collecting samples and information under the authority conferred upon them by the Secretary of Agriculture. A compilation of the definitions and standards for foods and drugs as they appear in the various State laws has been prepared and work has been begun upon the standards for food and drug products of foreign countries.

Assignment.—J. S. Abbott, H. S. Bailey.

Proposed expenditures, 1916-17.—\$13,000.

Interstate and Import Records:

Object.—To keep accurate records of interstate and import cases under the food and drugs act.

Cooperation.—Solicitor of the department.

Location.—Washington, D. C.

Date begun.—1908.

Assignment.—H. J. Demaree, M. E. Hartman.

Proposed expenditures, 1916-17.—\$21,500.

Preparation of Evidence for Cases:

Object.—To prepare evidence for presentation in cases under the food and drugs act and to secure outside witnesses and experts in cases. This project also covers cost of travel to court.

Cooperation.—Solicitor of the department.

Location.—Washington, D. C.

Date begun.—1907.

Assignment.—I. K. Phelps.

Proposed expenditures, 1916-17.—\$15,000.

Compilation of Information Regarding Food and Drug Products for Use in Enforcing the Food and Drugs Act:

Object.—A mass of information has accumulated in the files of the Bureau of Chemistry for a number of years, but is not accessible either for workers in the bureau or for workers on related subjects outside the bureau, because it is not in available form. This material will be compiled for distribution to chiefs of inspection districts, chemists in charge of branch laboratories, and chemists of the Bureau of Chemistry in Washington, in the enforcement of the food and drugs act, and also to State and city chemists engaged in the enforcement of State and municipal laws concerning foods and drugs. Such parts of the material as may be considered of sufficient value will be prepared for publication.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Information on the following subjects has been compiled and distributed: Almonds, baking powders, beverages—absinthe and maraschino liqueur; bouillon cubes, cacao products; cereal products—flour and graham flour; citrus products—oranges, orange juice, lime juice, and grapefruit; cheese; coffee—coffee extracts, coffee modifiers, coffee substitutes; drugs—quinine, strychnine, emodin-bearing drugs, iodine tincture (U. S. P.); liquors, liquid preparations, powders, pills, tablets, volatile oils, cannabis, santonica, drugs used in certain diseases; extracts—lemon, orange, and vanilla; gelatin and calf's foot jelly;

Compilation of Information Regarding Food and Drug Products for Use in Enforcing the Food and Drugs Act—Continued.

maple sugar, maple syrup; meat extracts; metals in foods—general methods, aluminum, arsenic, barium, and copper; methyl salicylate, birch oil, winter-green oil; oils—general methods, cottonseed, and olive; oysters, Peru balsam, potassium iodid (table of indices of solutions); preservatives—boric acid and salicylic acid; rice, scallops, tamarind syrup, canned tomatoes, tomato pastes, tomato catsup, vinegar (cider, distilled, and malt), sugar or sirup vinegar, and wine vinegar.

Assignment.—H. D. Gibbs, Courtney Conover.

Proposed expenditures, 1916-17.—\$3,000.

Total, Administration, \$52,500, including \$22,120 statutory.

FOOD CONTROL.

Preparation of Cases and Correspondence Relating to Foods:

Object.—To review cases, prepare correspondence, make analyses and check analyses, and compile data for court cases in connection with the enforcement of the food and drugs act.

Procedure.—Cases are received from the inspection districts and recommendations made as to their disposition. Correspondence is prepared dealing with such cases and with labels and other food questions arising under the food and drugs act. Check analyses of official samples are made by men with special experience along certain lines. Data are compiled for use in court cases and for use in reaching decisions on questions arising under the act.

Location.—Washington, D. C.

Date begun.—1907.

Results.—(1) During 1916: The preparation of Service and Regulatory Announcements, inaugurated in February, 1914, was continued until December, 1915, when this work was transferred to the administrative project of the bureau. During the past year about 8,400 interstate and import cases and cards have passed through the office for consideration or action. A monthly average of approximately 300 letters, exclusive of intrabureau memoranda and memoranda regarding cases, have been prepared. Fifty-four samples were analyzed for consideration in connection with cases. These figures do not include matters relating to the control of dairy products, which subject has not heretofore been reported under this project. The dairy-control work handled about 600 cases during the past year and answered about 60 letters per month.

(2) Prior to 1916: The publication of "Service and Regulatory Announcements," inaugurated in February, 1914, has been continued. This publication contains information and notices of a regulatory nature issued by the bureau, as well as notices of judgment obtained in trials under the food and drugs act.

Assignment.—I. K. Phelps.

Proposed expenditures, 1916-17.—\$27,000.

Examination of Waters and Related Products:

Object.—To make analyses of interstate and import samples, samples from source, review cases, handle correspondence, complete data for court cases, etc.

Procedure.—Samples collected by inspectors of presumably misbranded or adulterated products are analyzed. The source of waters is inspected to determine the possibility of contamination or other adulteration.

Location.—Washington, D. C.

Date begun.—1907.

Results.—Numerous successful prosecutions of adulterated or misbranded products have been made. However, very general compliance with the law is being secured. The sanitary condition of waters sold in interstate commerce and imported from abroad is being carefully controlled, the general condition being satisfactory.

Assignment.—W. W. Skinner, J. W. Sale, W. F. Baughman, F. B. Furber.

Proposed expenditures, 1916-17.—\$10,000.

Control of Stock Foods and Grains:

Object.—To make analyses of interstate and import samples, review cases, handle correspondence, complete data for court cases, etc.

Procedure.—Samples of cattle foods and grains offered for import and found in interstate commerce are collected and examined to determine whether they are in compliance with the provisions of the food and drugs act.

Cooperation.—Treasury Department, Department of Commerce, and Solicitor's office.

Control of Stock Foods and Grains—Continued.*Location.*—Washington, D. C.*Date begun.*—1907.*Results.*—General compliance with the law is being obtained. A special campaign against oats adulterated with water, barley, and screenings was made during 1916. Special campaigns were also started against cottonseed meals which were falsely branded relative to composition.*Assignment.*—J. K. Haywood, G. L. Bidwell.*Proposed expenditures, 1916–17.*—\$9,700.**Preparation of Cases and Correspondence Relating to Carbohydrate Products:***Object.*—To review cases, prepare correspondence, make check analyses of official samples, and compile data for court cases.*Procedure.*—Cases concerning confectionery, sugars, sirups, jellies, jams, and preserves, and all cases relating to other food products in which a charge is made concerning a carbohydrate constituent are considered for the purpose of making recommendation as to their disposition. Correspondence dealing with such cases and with labels and other food questions arising under the food and drugs act is prepared. Check analyses of official samples, when necessary, are made by men with special experience along certain lines. Data for use in court cases and for use in reaching decisions on questions arising under the act are compiled.*Location.*—Washington, D. C.*Date begun.*—1914.*Results.*—During the past year 2 import and 9 miscellaneous samples of foods were analyzed and reported, and 1 check analysis was made in connection with an interstate case. About 150 letters and memoranda a month, exclusive of memoranda regarding cases, cards, etc., have been prepared. Approximately 750 interstate cases and cards on food samples have been reviewed and appropriate recommendations prepared.*Assignment.*—C. S. Hudson, M. N. Straughn, S. F. Sherwood, J. K. Dale.*Proposed expenditures, 1916–17.*—\$5,000.**(Control of Dairy Products:** Discontinued as a separate project; included under "Preparation of Cases and Correspondence Relating to Foods.")**Microchemical Examination of Food and Drug Products:***Object.*—To make analyses of interstate and import samples, review cases, handle correspondence, etc.*Procedure.*—Samples are examined microscopically and such other work as is necessary in connection with cases is performed.*Location.*—Washington, D. C.*Date begun.*—1907.*Results.*—Many prosecutions have been brought as a result of the analyses made by this laboratory. Among the more important classes which have been handled are eggs, spices, tomato products, dried fruits, certain drug products, pork and beans, and nuts.*Assignment.*—B. J. Howard.*Proposed expenditures, 1916–17.*—\$7,600.**(Milk Campaign:** Discontinued as a separate project; included under "Microbiological Examination of Foods and Drugs.")**Microbiological Examination of Foods and Drugs:***Object.*—To detect adulteration, contamination, and pollution in foods and drugs.*Procedure.*—Samples of foods and drugs are examined and cases developed on those warranting action under the food and drugs act. The analysts appear as witnesses when required.*Location.*—Headquarters at Washington, D. C.; temporary laboratories in other cities.*Date begun.*—1914.*Results.*—Bacteriological analyses of official samples of foodstuffs in which filth, decomposition, or putridity is suspected have been made. Tomato products, sardines, condensed milk, dried and frozen eggs, and oysters have furnished samples calling for expert interpretation. Miscellaneous samples have been analyzed as fully as information has permitted. Culture media for the Washington, New York, and Chicago branch laboratories and for various field parties have been prepared.*Assignment.*—Charles Thom.*Proposed expenditures, 1916–17.*—\$16,840.

Nitrogen Determinations:

Object.—To determine the nitrogen content of samples of various products when such determinations are necessary in the analysis of these products.

Procedure.—Official analytical methods are employed in the determination of the nitrogen content of samples submitted by other laboratories of this bureau and by other bureaus of the department.

Location.—Washington, D. C.

Date begun.—1901.

Results.—14,000 determinations have been made and reported.

Assignment.—H. W. Daudt.

Proposed expenditures, 1916-17.—\$3,000.

Total, Food Control, \$79,140, including \$14,210 statutory.

DRUG CONTROL.**Expert Review of Analyses and Recommendations on Drug Samples:**

Object.—To secure the uniform, consistent, and effectual enforcement of the food and drugs act in its application to drugs.

Procedure.—The analytical findings and recommendations of inspection districts in connection with evidence presented at hearings are critically reviewed.

Location.—Washington, D. C.

Date begun.—1907.

Results.—Gradual improvement in the quality and labeling of drugs has resulted.

Assignment.—L. F. Kebler, W. O. Emery, E. K. Nelson.

Proposed expenditures, 1916-17.—\$4,000.

Drug Analyses:

Object.—To conduct analyses of interstate and import drugs and drug products to determine whether such products are in compliance with the food and drugs act.

Procedure.—Established methods of analysis will be employed where available; otherwise newly developed methods will be used.

Location.—Washington, D. C.

Date begun.—1907.

Results.—The results of these analyses have been used as a basis for action in the enforcement of the food and drugs act and also, in cooperation with other departments, in the enforcement of various other laws.

Assignment.—L. F. Kebler, W. O. Emery, E. K. Nelson, C. D. Wright, G. C. Spencer, S. Palkin, W. S. Hubbard.

Proposed expenditures, 1916-17.—\$12,000.

Examination of Turpentine and Rosin:

Object.—To examine turpentine and rosin samples to determine whether or not they are adulterated, to check analyses, and to pass upon cases on turpentine and rosin under the food and drugs act.

Location.—Washington, D. C.

Date begun.—1906.

Results.—Examination has been made of samples taken from interstate shipments and the results reported for use in enforcing the food and drugs act in its application to rosin and turpentine.

Assignment.—F. P. Veitch, H. P. Holman.

Proposed expenditures, 1916-17.—\$512.

Crude-Drug Control:

Object.—To inspect imported drugs arriving at ports where drug-inspection facilities are limited; to check important work on import and interstate cases; and to prepare standards and collect data, with the object in view of securing uniformity in drug inspection.

Procedure.—The usual methods of pharmacognostic investigations are followed.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Considerable work on crude drugs has been completed. Data have been collected for the guidance of administrative offices in enforcing the food and drugs act in its application to crude drugs.

Assignment.—A. Viehoever, C. O. Ewing, J. F. Clevenger.

Proposed expenditures, 1916-17.—\$6,860.

Supervision of Sherley Amendment Cases:

Object.—The consideration of therapeutic claims made for medicinal preparations and the supervision in the bureau of cases arising under the Sherley amendment to the food and drugs act, including assistance, when necessary, in the presentation of cases in court.

Procedure.—This is principally an administrative project. All cases prepared by the inspection districts, involving the Sherley amendment to the food and drugs act, are considered by this office. Such administrative work as may be necessary to carry on the case to termination is conducted.

Cooperation.—Bureau of the Public Health Service of the Treasury Department and the Bureau of Animal Industry.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Numerous successful prosecutions of cases under the Sherley amendment to the food and drugs act have been made. A separate office for the systematic handling of cases under the Sherley amendment was organized during the fiscal year 1916.

Assignment.—M. W. Glover, detailed from the Bureau of Public Health Service of the Treasury Department, and A. J. McIntyre, T. C. Merrill, and F. P. Morgan, of the Bureau of Chemistry.

Proposed expenditures, 1916-17.—\$11,000.

Total, Drug Control, \$34,372, including \$3,860 statutory.

FIELD FOOD AND DRUG INSPECTION.**Inspection Work:**

Object.—To collect samples, inspect factories, and secure data bearing on food and drug industries.

Cooperation.—State food and drug inspectors and Bureau of Animal Industry inspectors.

Location.—District headquarters at Washington, D. C., Chicago, Ill., and San Francisco, Cal. Inspectors travel over the whole United States.

Date begun.—1907.

Results.—A large number of samples have been collected, factories inspected, and data assembled.

Assignment.—W. G. Campbell, L. M. Tolman, B. R. Hart.

Proposed expenditures, 1916-17.—\$130,000.

Hearings and Correspondence:

Object.—To hold hearings, conduct correspondence, and prepare cases at district headquarters and at branch laboratories, in connection with the enforcement of the food and drugs act as applied to both interstate and import business.

Location.—District headquarters at Washington, D. C., Chicago, Ill., San Francisco, Cal., and at branch laboratories.

Date begun.—1907.

Assignment.—W. G. Campbell, L. M. Tolman, B. R. Hart.

Proposed expenditures, 1916-17.—Included in cost of laboratories listed below.

Examination of Samples:

Object.—To make chemical and other analyses of samples of foods and drugs to determine whether or not they are adulterated or misbranded.

Location.—District headquarters and branch laboratories of the Bureau of Chemistry.

Date begun.—1907.

Assignment.—W. G. Campbell, L. M. Tolman, B. R. Hart.

Proposed expenditures, 1916-17.—Included in cost of laboratories listed below.

Insecticide Work:

Object.—To hold and report hearings, collect samples of both interstate and import shipments, and conduct other routine work in connection with the enforcement of the insecticide act.

Cooperation.—Insecticide and Fungicide Board.

Location.—District headquarters and branch laboratories.

Date begun.—1910.

Assignment.—W. G. Campbell, L. M. Tolman, B. R. Hart.

Proposed expenditures, 1916-17.—Included in cost of laboratories listed below.

Regulatory Investigations:

Object.—To develop methods of analysis, detect and study new adulterants, secure data on trade practices, and study food and drug industries, in order to enforce properly the food and drugs act.

Location.—District headquarters and branch laboratories.

Date begun.—1907.

Assignment.—W. G. Campbell, L. M. Tolman, B. R. Hart.

Proposed expenditures, 1916-17.—Included in cost of laboratories listed below.

BRANCH FOOD AND DRUG LABORATORIES.

Location.	Assignment.	Proposed expenditures, 1916-17.
Eastern district; headquarters, Washington, D. C.....	W. G. Campbell, chief of district.....	
Washington, D. C.....	A. L. Sullivan.....	\$37,000
New York, N. Y.....	R. E. Doolittle.....	81,400
Boston, Mass.....	E. J. Shanley.....	20,500
Philadelphia, Pa.....	C. S. Brinton.....	9,300
Buffalo, N. Y.....	L. Patton.....	9,400
Savannah, Ga.....	W. J. McGee.....	8,900
San Juan, P. R.....	B. B. Wilcox.....	5,000
Central district; headquarters, Chicago, Ill.....	L. M. Tolman, chief of district.....	
Chicago, Ill.....	G. W. Hoover.....	61,500
Minneapolis, Minn.....	E. H. Goodnow.....	9,400
St. Louis, Mo.....	D. B. Bisbee.....	9,400
Cincinnati, Ohio.....	L. B. Forst.....	11,400
New Orleans, La.....	F. W. Liepsner.....	9,170
Western district; headquarters, San Francisco, Cal.....	B. R. Hart, chief of district.....	
San Francisco, Cal.....	R. W. Hiltz.....	32,264
Seattle, Wash.....	A. L. Knisely.....	11,000
Denver, Colo.....	R. S. Hiltner.....	17,000
Honolulu, Hawaii.....	A. W. Hansen.....	4,000
		336,634

Total, Field Food and Drug Inspection, \$466,634, including \$162,380 statutory.

[Research.]

FOOD INVESTIGATIONS.**Studies on the Analysis and Composition of Vinegars:**

Object.—To develop methods of analysis and to acquire knowledge of the composition of vinegars.

Procedure.—Methods of analysis of vinegars in general are investigated and these methods applied to the determination of the composition of authentic samples of the different vinegars. For the present the work will be devoted more particularly to vinegars made from sugar or molasses and from corn-starch sugar, and will be extended later to spirit, wine, malt, and cider vinegars.

Cooperation.—Vinegar manufacturers.

Location.—Washington, D. C.

Date begun.—1914.

Results.—During the past year an investigation of the composition of cider vinegar made from two lots of mixed apples grown in Virginia was completed and the results prepared for publication. An investigation of the plant and processes used in the manufacture of so-called molasses vinegar was made and a report submitted in connection with one of the cases arising under the food and drugs act. Glycerin was isolated in considerable quantity from cider vinegar and positively identified, so that there can no longer be any doubt as to its presence in this vinegar. Work on the identification of the volatile reducing substance occurring in cider vinegar was continued and is nearly completed.

Assignment.—R. W. Balcom, E. G. Grab.

Proposed expenditures, 1916-17.—\$5,500.

Study of the Composition of American Oils and Fats:

Object.—To determine the composition of oils and fats used in foods, in order to obtain data for standards; to determine adulterants in such oils and fats; and to improve methods of analysis.

Study of the Composition of American Oils and Fats—Continued.

Procedure.—Methods for the analysis of oils and fats are investigated and the most desirable ones applied to the analysis of authentic samples of American oils and fats.

Cooperation.—Manufacturers and refiners.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Official methods have been thoroughly investigated and, wherever possible, applied to the analysis of the material collected. New methods described in the literature on the subject have been tried and in some cases adopted, and changes in old methods, where such seemed necessary, have been worked out. Authentic samples of cocoa butter and substitutes, tomato-seed oils, and charlock oils have been collected and analyzed. A paper upon the composition of charlock oil appeared in the May, 1916, number of the Journal of Industrial and Engineering Chemistry. The results of the tomato-seed oil investigation are being prepared for publication, and the data obtained upon cocoa butter and cocoa butter substitutes were presented at the Portland meeting of the Association of American Dairy, Food, and Drug Officials. These data have since been supplied to the chemists of the bureau in the form of information cards on cocoa products. A part of the results obtained in connection with the investigation of peanut oil have appeared in Farmers' Bulletin 751, published jointly with the Bureau of Plant Industry.

Assignment.—H. S. Bailey, L. B. Burnett.

Proposed expenditures, 1916-17.—\$1,000.

Study of the Occurrence of Heavy Metals in Natural and Manufactured Food Products and of Methods for Their Determination:

Object.—To develop standard and more accurate analytical methods for the determination of heavy metals in foods and food materials, and to determine the extent of the natural occurrence of heavy metals in foods and the sources and amounts of heavy metals found in food products ready for consumption.

Procedure.—The work probably will be taken up in the following order: Lead in baking powder, baking chemicals, and acid phosphate; arsenic in hops, sulphur, baking powder, baking chemicals, acid phosphate, and gelatin; tin in canned goods; zinc in gelatin, dried fruit, and acid phosphate. Methods of analysis will be worked out in the laboratory. Analyses of authentic samples will be made and processes of food preparation investigated to find the source of heavy metals in foods.

Cooperation.—Food manufacturers and chemists engaged in the control of food manufacture and the Association of Official Agricultural Chemists.

Location.—Washington, D. C.

Date begun.—1913.

Results.—During the fiscal year 1916 methods for the determination of lead in baking powder have been studied and progress made, so that the work will probably be completed by December, 1916. Methods for the determination of arsenic in hops and in sulphur have been tested and a satisfactory method has been adopted. The occurrence of slivers of steel in stock feed from tin-plate cleaning material has been investigated. A report to the chief of the bureau discusses the effect of the feed on animals and the possibility of the removal of the steel from the feed. The manufacture of tin plate and tin cans and the canning of various products have been followed in a cooperative experiment with some commercial concerns, and a report of this work has been submitted to the chief of the bureau. Methods for the determination of arsenic and tin were tested by a number of collaborators and the results discussed at the meeting of the Association of Official Agricultural Chemists in November, 1915. A report will be published in volume 2 of the journal of that association. As a result, two methods for the determination of tin were adopted by the association as provisional, and one method for arsenic was recommended for publication in the journal and for future consideration.

Assignment.—W. D. Collins, E. L. P. Treuthardt.

Proposed expenditures, 1916-17.—\$5,700.

Studies in the Chemistry of Essential Oils and Natural and Synthetic Flavors and Flavoring Extracts Prepared therefrom:

Object.—To devise new or to extend selected established methods of analysis, to secure data as a basis for standards, and to determine the composition of authentic materials.

Procedure.—The ester content of some citrus oils will be established. Work on a chemical method for distinguishing between natural and imitation oil of winter-

Studies in the Chemistry of Essential Oils and Natural and Synthetic Flavors and Flavoring Extracts Prepared therefrom—Continued.

green will be continued. Investigations also will be conducted to determine the compositions of the flavoring materials of grapes and of muskmelons and the behavior of some essential oils and constituents thereof on hydrogenation. The analysis of some synthetic flavors will be studied.

Cooperation.—On a limited scale with essential-oil distillers.

Location.—Washington, D. C.

Date begun.—1915.

Results.—(1) During 1916: A method for the accurate determination of volatile esters in lemon oils and extracts was worked out and published in the Journal of the American Chemical Society, vol. 37, October, 1915. A considerable part of the work upon the elaboration of a method for detecting synthetic methyl salicylate when sold as oil of wintergreen was finished. The flavoring material of Concord grapes was isolated in small quantity and its composition in part established.

(2) Prior to 1916: An apparatus had been devised for the quantitative measurement of the course of the reaction which takes place when certain bodies are catalytically hydrogenated. With this apparatus the behavior of some essential oils and of their single constituents was studied and the "hydrogen number" of certain oils determined. The results were published in the Journal of the American Chemical Society, vol. 36, October, 1914. The acidity of vanillin on titration in alcoholic-aqueous solution was determined and a method developed for the estimation of vanillin in vanilla extracts. This was published in the Journal of Industrial and Engineering Chemistry, vol. 7, June, 1915.

Probable date of completion.—1919.

Assignment.—A. R. Albright.

Proposed expenditures, 1916-17.—\$4,250.

Investigation of the Effect of Hydrogenation upon Oils Intended for Use as Food Products:

Object.—To determine the nature of the changes taking place in various oils during the process of hydrogenation, with special relation to the change in the analytical constants and to the production of isomeric glycerids of the fatty acids under different known conditions; and to prepare for use in nutrition investigations hardened oils of known history.

Procedure.—Authentic oils will be hydrogenated under known, and, as nearly as possible, under commercial conditions. Samples will be analyzed from time to time throughout the entire process. The exact chemical composition of the original and resulting products will be determined.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Little is known on this subject at present. Several catalyzers have been made and a small amount of hardened oils prepared with each of these.

An experimental hydrogenator has been built and used.

Probable date of completion.—1918.

Assignment.—H. S. Bailey, L. B. Burnett.

Proposed expenditures, 1916-17.—\$2,500.

Investigation of the Sweating of Citrus Fruits:

Object.—To investigate the methods in vogue for accelerating the coloring of green citrus fruits, and to ascertain the effect of the so-called "sweating" upon the composition, flavor, and the keeping and shipping qualities of the fruit.

Procedure.—Three methods of procedure will be employed: (1) Conditions of sweating as carried out by the operators at the present time will be studied, temperature and moisture conditions being noted, and analyses made of the sweat-room atmosphere and of the fruit before and after sweating. As far as the composition of the fruit is concerned, the analyses will be carried further than the usual sugar and acid determinations. An attempt will be made to determine also volatile acids and esters. Fruit in different stages of maturity from different localities and grown on different types of soil will be used. (2) Sweat rooms of one to four boxes capacity will be constructed in the laboratory and the problem studied under conditions which can be adequately controlled and where a synthetic atmosphere can be supplied. The same line of investigation will be carried on under these conditions as under the first method, outlined above. (3) The third stage of the procedure will be the storage of sweated and unsweated fruit, in order to note the effect of the sweating process upon

Investigation of the Sweating of Citrus Fruits—Continued.

composition and eating and keeping qualities. After the sweat rooms in the northern portion of the California citrus region have ceased operations for the season the work will be transferred to one of the large lemon houses in the southern part of the State, where the work will be continued.

Location.—Headquarters, Los Angeles, Cal.; temporary stations at other points.

Date begun.—1914.

Results.—Preliminary work was inaugurated in the fall of 1914, and a study of the atmosphere contained in the sweat rooms was made and the effect of the gases found therein upon green fruit tried on a laboratory scale. A few analyses were made before and after sweating and after storage. The results indicated that there was in all probability a material change in the composition of sweated fruit.

During the fiscal year 1916 a small sweat room was built and a few trials made.

Probable date of completion.—July, 1918.

Assignment.—E. M. Chace.

Proposed expenditures, 1916-17.—\$2,000.

Study of the Composition of California Citrus Fruits:

Object.—To ascertain the composition of California citrus fruits, with a view to establish, if possible, definite standards of maturity; to ascertain the effect of storage at various stages of maturity upon the composition.

Procedure.—Trees are located in different sections of the citrus-producing regions of California, upon different types of soil, and at different altitudes. Samples are taken from these trees at stated periods, usually once each week, and analyses made immediately. Where samples can not be collected by the laboratory force, they are mailed by the grower or packing-house agent to the laboratory. Fruit at different stages of maturity is placed in storage and samples from each lot analyzed at weekly intervals. Data concerning methods of cultivation, irrigation, fertilization, and grove management are collected upon the groves from which samples are taken, in order that abnormalities occurring may be accounted for, if possible.

Cooperation.—Various growers and associations throughout California and Arizona.

Location.—Los Angeles, and the citrus-producing regions of California and Arizona.

Date begun.—1913.

Results.—The work on oranges has been completed, and the standard recommended has been adopted by 95 per cent of the growers and packers in California, resulting in a marked improvement in the quality of the fruit shipped and in returns to the growers. Preliminary work on grapefruit was started during 1916, but the data will not be available for consideration until September. Some work has also been done on Valencias and tangerines.

Probable date of completion.—September, 1917.

Assignment.—E. M. Chace, C. G. Church.

Proposed expenditures, 1916-17.—\$3,000.

Study of Experimental Packs of Canned Foods:

Object.—To collect information on tin content, acids, net weight, proper fill, and presence of added water in connection with canned foods; to determine the effect of storage and the effect of coatings upon canned goods; and to study the relation of grading to quality.

Procedure.—This work is carried out largely in commercial canneries by preparing canned goods of known quality under known conditions. A determination of the effect of the contents on the tin coating is made at intervals. A study is made of the maximum fill of cans possible with different substances which will still permit of the proper processing and sealing. In certain canned foods the addition of water is considered an adulteration, and it is necessary to devise methods for the detection of small amounts of added water in such canned foods. It is intended to put up experimental packs of peas and beans for examination as to quality and fill of can and to devise methods for detecting soaked products. An exhaustive study of tomato products is also contemplated.

Cooperation.—Commissary General, United States Army; field inspection force, Bureau of Chemistry; and commercial canneries.

Location.—Washington, D. C.

Date begun.—1909.

Results.—(1) During 1916: No work was done under this project during the fiscal year 1916 owing to a shortage of laboratory assistance and the pressure of other work. A compilation of past work is intended before the end of the present fiscal year.

(2) Prior to 1916: 107 samples of experimental packs were analyzed and reports made to the Commissary General, United States Army; representative

Study of Experimental Packs of Canned Foods—Continued.

samples of peas and beans of various qualities were analyzed in connection with the Bureau of Chemistry's exhibit at the Panama-Pacific Exposition at San Francisco; samples of tomatoes and tomato juice packed under the bureau's supervision were analyzed with a view to the detection of added water. Experimental packs of oysters, clams, and shrimp were prepared and examined and the proper fills of cans of these substances determined. Analyses of experimental packs of 30 different substances, consisting of 170 samples, were made from 1910 to 1913, inclusive. Considerable information on the tin content and acidity of canned goods was obtained from these examinations, the results of which are now under consideration and should prove of value in connection with Food Inspection Decision 126. An examination of experimental packs of California fruits was made, the results of which have been published in Department Bulletin 196, "Methods Followed in the Commercial Canning of Foods."

Probable date of completion.—1920.

Assignment.—E. L. P. Treuthardt.

Proposed expenditures, 1916-17.—\$1,800.

Investigation of Canning Processes and Canning Methods:

Object.—To ascertain the effect of different methods of treatment of raw material and of other factors upon the composition of canned goods; also to study filling machines:

Procedure.—Food products stored and canned under various known conditions will be collected and examined, with a view to determine the effect of such conditions on the finished product. This work will be carried on to some extent at commercial canneries, and a study of filling machines also will be made. During the coming year it is planned to make a special study of the raw materials used in the packing of tomatoes and peas, with a view to the better understanding of the quality of these products.

Cooperation.—Commercial packing houses and Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1909.

Results.—(1) During 1916: A study of the packing of corn in Maine was made. Samples containing varying amounts of starch were packed by representatives of the bureau and examined.

(2) Prior to 1916: Samples of Italian tomato paste were collected in Italy by an expert of this bureau and analyzed. The information obtained has assisted in the detection of spoilage and excessive dirt in these products. Samples of blighted and unblighted tomatoes were canned and analyzed, and a means of distinguishing between blighted and watered tomatoes is being developed.

Probable date of completion.—1918.

Assignment.—E. L. P. Treuthardt.

Proposed expenditures, 1916-17.—\$1,200.

(Commercial Egg Denaturing: Project completed. The object of this work was to denature unsound eggs in order to make them unsalable for food purposes, and to utilize such denatured material for industrial purposes. Investigation has shown that birch tar oil fulfills all the requirements of a satisfactory denaturant and meets with the general approval of the tanners. Denatured egg yolk applied on a commercial scale at various plants in tanning leather resulted in no injury to the leather in color, odor, or quality. The color was unaffected even in the cases of white and delicately colored leathers. Laboratory experiments indicate that "power distillate" (a petroleum product) may be used as a substitute for birch tar oil, but experiments have not been conducted at tanneries with this material, nor has its effect upon the leather produced been determined. Complete specifications for denaturants and directions for denaturing have been prepared. A statement of the investigation is being prepared for publication.)

Study of Methods of Preparing Egg Oil from "Off Grade" Eggs:

Object.—To devise a cheap and efficient means for the separation of the oil and leather-tanning constituents from this class of eggs, and to encourage the use of this oil in the leather-tanning industry, thereby affording a ready and suitable market for eggs of a quality unsuitable for food purposes.

Procedure.—Preliminary work will be done in the laboratory at Washington, and ultimately a field laboratory will be established at some point in the egg-breaking centers to work out methods and their application to the separation of oil and lecithin from waste eggs.

Study of Methods of Preparing Egg Oil from "Off Grade" Eggs—Continued.*Cooperation.*—Egg-breaking firms and tanneries.*Location.*—Headquarters, Washington, D. C.*Date begun.*—1913.*Results.*—In order to test methods of separation and extraction a quantity of oil and extractives has been prepared in the laboratory. Some of this prepared material will be submitted to tanners to determine its value for leather-tanning purposes. When a suitable method and material have been developed, consideration will be given to their commercial application.*Probable date of completion.*—1917.*Assignment.*—H. W. Houghton.*Proposed expenditures, 1916-17.*—\$1,000.

(**Sardine Investigations:** Project completed. Lack of attention to ordinary methods of cleanliness was found to be the greatest factor responsible for the production of a low-grade article. Bacteriological growth has been shown not to be an important factor in the sanitary and hygienic conditions. Circular letters were sent to all the individual companies in the industry, making suggestions for sanitary and hygienic improvements and also suggesting improved ways to handle and pack the fish. Many improvements were made as a result of these suggestions. Many of the canneries were put in a first-class condition. This produced an estimated improvement of 33 per cent in the quality of the 1914 season's pack. Corn oil has been found to be a satisfactory substitute for cottonseed oil in the packing of sardines. The following methods of utilizing waste have been studied and advocated: (1) The use of a longer can to fit the larger fish, rather than cutting away a large part of the fish to fit a small can; and (2) the preparation of sardine paste and deviled sardines, kippered herring, "herring chunks," and "Bismarck" herring, and fish-meat meal as a stock food. Feeding experiments in cooperation with the Bureau of Animal Industry were conducted with fish meal prepared from the waste in the sardine industry. The results showed that fish meal, prepared for feeding purposes, is as valuable as the high-protein concentrates now generally used, and that in certain cases, when compared with tankage for feeding hogs, it is more valuable. The results of these tests are incorporated in Department Bulletin 378, "Fish Meal: Its Use as a Stock and Poultry Food." A device for positioning fish and a machine for cutting off the heads and removing the viscera from fish have been designed, and applications for patents have been made. In the study of the cause of "swells" in cans of sardines the results of bacterial examinations showed the specific cause of the trouble to be a spore-bearing organism.)

Study of Wheat and Wheat Flour with Reference to the Effects of the Commercial Bleaching Processes:*Object.*—To study the effects of aging and bleaching processes on the properties of flour as evidenced by the products (bread, etc.) made from flour; to study chemical processes for the detection of bleaching, etc.*Procedure.*—Studies are made of flours of various ages, kinds, and grades, both unbleached and bleached, when made into bread, etc., under domestic, laboratory, and commercial conditions.*Cooperation.*—Flour warehousemen, millers, and bakers.*Location.*—Washington, D. C.*Date begun.*—1915.*Probable date of completion.*—1917.*Assignment.*—I. K. Phelps, B. R. Jacobs.*Proposed expenditures, 1916-17.*—\$5,000.**Investigation of the Manufacture and Composition of Sauerkraut and Pickles:***Object.*—To study the normal, as well as abnormal, fermentation of sauerkraut and pickles and the methods of overcoming losses from various causes; and to determine the normal composition of good kraut, the proper fill of canned kraut, the use of pure cultures in its manufacture, and the utilization of waste products.*Procedure.*—Laboratory experimentation and field investigations are made at the proper seasons.*Cooperation.*—Manufacturers.*Location.*—Washington, D. C., and field laboratories to be established, where necessary.*Date begun.*—1915.

Investigation of the Manufacture and Composition of Sauerkraut and Pickles—Continued.

Results.—During the past year sauerkraut factories were inspected, laboratory work was carried on, and a detailed study of the fermentation processes in certain factories made. Authentic samples canned under the direction of the investigators are now being analyzed chemically.

Probable date of completion.—1918.

Assignment.—L. A. Round, S. Coopersmith.

Proposed expenditures, 1916-17.—\$1,500.

Study of Poisonous Elements on Fruits and Vegetables Sprayed with Poisonous Sprays:

Object.—To determine what quantity of poisonous elements remains on fruits and vegetables sprayed with poisonous sprays; to ascertain whether such poisonous elements can be removed by the consumer; to learn how to determine the quantity of poisonous elements that may be present by reason of the excessive use of sprays; and to find out whether changes can be made in time and method of spraying by which danger from injurious metals may be lessened.

Procedure.—Various kinds of fruit trees and vegetables will be sprayed according to the accepted schedules and the composition of the fruits as they reach the consumer studied. Fruits and vegetables will be treated in various ways to see whether poisonous metals can be removed. Excessive amounts of insecticides and fungicides will be sprayed to determine how much of the injurious metals may be present under adverse conditions, and methods of so changing the usually accepted spraying schedules as to lessen or eliminate danger from the poisonous elements will be studied. All of the analytical work will be performed at the bureau headquarters in Washington. The spraying will be done at the Arlington Farm, Va., on rented trees, if necessary, and at various orchards throughout the United States where agents of the department are carrying on experimental work.

Cooperation.—It is planned to make this a cooperative study by the Bureaus of Chemistry, Plant Industry, and Entomology. It is possible that some of the State experiment stations also will be asked to aid in the work by spraying lots of trees in accordance with definite instructions and by sending the fruit to Washington for examination.

Location.—Washington, D. C., Arlington Farm, Va., and orchards in various sections of the United States.

Date begun.—1915.

Results.—A large amount of analytical data has been obtained during the past year, but the results can not be judged until these data have been collated at the end of the investigation.

Assignment.—W. D. Lynch, J. K. Haywood, C. C. McDonnell.

Proposed expenditures, 1916-17.—\$3,500.

Investigation of Color Substances, with Special Reference to Food and Drug Products:

Object.—To investigate the formation and methods for detection, isolation, comparison, and determination of structure of color substances, both natural and artificial, used in food and drug products.

As applied to agricultural research, this investigation is designed to include the study of various compounds synthesized by plants with special reference to their detection and to the investigation of their properties, structure, identification, and synthesis.

Procedure.—Primarily, it will be necessary to obtain or manufacture various pure substances largely of an organic nature. These compounds will be prepared from plants or plant products or will be synthesized and a study made of their chemical and physical properties.

Location.—Washington, D. C.

Date begun.—1915.

Results.—A number of pure dyes were prepared during the past year for the purpose of promoting general investigations. A study of the manufacture of certain compounds necessary for the production of dyes was also begun. Color comparison standards for green and ripe oranges have been practically completed.

Assignment.—H. D. Gibbs.

Proposed expenditures, 1916-17.—\$6,000.

Study of Vanilla and Tonka Beans and Their Extracts:

Object.—To determine the composition of the beans, extracts, and waste products arising from different methods of manufacture.

Procedure.—It is planned to visit importers and obtain authentic samples of beans, in order to detect washed beans if possible. Manufacturers of extracts will be asked to furnish samples and permit a study of their methods of manufacture. The results secured in this way will be compared with those obtained in the study of extracts prepared by a standard laboratory method and also in the study of extracts prepared in the laboratory by methods similar to those used in manufacturing.

Cooperation.—Importers of beans and manufacturers of extracts.

Location.—Washington, D. C., and the field.

Date begun.—1915.

Probable date of completion.—1917.

Assignment.—C. O. Dodge.

Proposed expenditures, 1916-17.—\$700.

Investigation of Enameled Cooking Utensils:

Object.—To determine the composition of the various forms of enamel used on cooking utensils and their solubility in different food products or ingredients.

Procedure.—Samples of enameled wares of various makes will be purchased and the enamel analyzed. Cooking experiments with a variety of food products or ingredients will then be carried out to determine the solvent action on the different types of enamel.

Location.—Washington, D. C.

Date begun.—1915.

Results.—A preliminary study has been made of the composition of 25 samples of enameled wares.

Probable date of completion.—1917.

Assignment.—C. O. Dodge, E. L. P. Treuthardt.

Proposed expenditures, 1916-17.—\$1,000.

(Investigation of Methods of Analysis for Fruit Products: Discontinued as a separate project; further work along this line to be done under Organic Chemical Investigations, project "Organic Acids of Nature." A study was made of methods for the determination of malic, citric, and tartaric acids. The results were presented at the November, 1915, meeting of the Association of Official Agricultural Chemists and will be published in the journal of that association, vol. 2.)

Study of Green and Roasted Coffee:

Object.—To investigate the changes which take place in coffee upon roasting, secure information on the moisture content of green and roasted coffee and changes in moisture in storage, study the glazing or coating of coffee, investigate the commercial grades of coffee, and secure data for establishing a standard for coffee to be imported.

Procedure.—Commercial practices in grading and roasting coffees are studied, including the collection and analysis of samples. Authentic samples of coffee are obtained from Brazil and examined for black and spoiled beans, overripe, shriveled, and immature beans, and for bean shells and foreign matter. Further work is contemplated on the determination of moisture in roasted coffee and on the chemical and physical study of specific forms of objectionable constituents of commercial coffee.

Cooperation.—State Department and manufacturers.

Location.—Washington, D. C., New York, Maryland, Pennsylvania, Missouri, and Louisiana.

Date begun.—1915.

Results.—Preliminary reports on coating and grading of coffees were submitted at the beginning of this work. Ninety-one samples of coffees have been graded and examined with the view of studying the relation of grade to objectionable material present. Chemical analyses have been made on both green and roasted coffees. Other samples have been received and will be examined.

Probable date of completion.—1918.

Assignment.—I. K. Phelps, A. Viehoever.

Proposed expenditures, 1916-17.—\$700.

Study of Gelatin:

Object.—To study the chemical composition, methods of manufacture, and the uses and requirements of gelatin for foods and its differentiation from gelatin for industrial purposes.

Procedure.—The service which gelatin performs in food mixtures will be ascertained and experiments made in cooperation with users to understand their needs. The relation of gelatin to the parent substance ossein of bones will be studied and an investigation made of the yield and practicable improvement in the output and quality of gelatin as adapted to the requirements for food and industrial uses. A study will be made of the optical and other properties of gelatin so that its chemical nature may be understood and that it may be possible to estimate and standardize it as to strength and purity and detect and determine it in mixtures.

Cooperation.—Bureau of Animal Industry.

Location.—Food and Drug Inspection Laboratory, New York City.

Date begun.—1916.

Probable date of completion.—1919.

Assignment.—C. R. Smith.

Proposed expenditures, 1916-17.—\$1,500.

Maturity Test for Muskmelons:

Object.—To ascertain the possibility of devising tests for ascertaining the maturity of muskmelons.

Procedure.—Studies will be made of the growth of the melons, both as to physical characteristics and chemical composition. Melons will be shipped and held in storage for definite periods to ascertain the changes in composition when picked at different degrees of maturity.

Cooperation.—Bureau of Plant Industry and with growers.

Location.—Headquarters, Los Angeles, Cal. Field work will be conducted at El Centro, Cal., and in other muskmelon-growing sections of California and Arizona. Laboratory work in Washington.

Date begun.—1916.

Probable date of completion.—1919.

Assignment.—E. M. Chace, A. R. Albright, C. G. Church.

Proposed expenditures, 1916-17.—\$1,000.

Detection of Commercial Acetic Acid in Catsup by Means of the Formic-Acid Determination:

Object.—To find out whether the use of commercial acetic acid in the preparation of catsup can be detected with certainty by a determination of the formic acid introduced into the catsup through the acetic acid used.

Procedure.—Fincke's method will be used to secure data on the amount of formic acid present in acetic acid manufactured in this country, and this method or some practical modification of it, which may have to be devised, will be used in the examination of catsups prepared with and without commercial acetic acid.

Cooperation.—The samples of catsup will be obtained from catsup manufacturers, and their cooperation to the extent of granting permission to watch the manufacture of the catsup from which the samples are taken will be necessary.

Location.—Washington, D. C.

Date begun.—July, 1916.

Probable date of completion.—1918.

Assignment.—R. W. Balcom, E. G. Grab.

Proposed expenditures, 1916-17.—\$500.

Study of a Method for Determining Volatile Amines in the Presence of Ammonia:

Object.—To find a reagent or method by which volatile amines may be detected and estimated in food products. This should be valuable in deciding the extent of spoilage of certain foods.

Procedure.—The reactions of ammonia and different amines with different reagents will be investigated in an effort to find certain reagents which will give distinctive tests with the amines so that they may be separated from ammonia and from each other.

Location.—Washington, D. C.

Date begun.—July, 1916.

Probable date of completion.—1920.

Assignment.—C. L. Alsberg, H. E. Woodward.

Proposed expenditures, 1916-17.—\$600.

Total, Food Investigations, \$59,950, including \$2,560 statutory.

PHYSICOCHEMICAL INVESTIGATIONS.

Physicochemistry and Engineering of Carbonation:

Object.—To determine the physical and chemical characteristics of carbonated liquids; to ascertain the machinery processes which produce given carbonation effects.

Procedure.—An experimental study is made of carbonated liquids prepared under known laboratory conditions and of carbonated liquids sold in trade, supplemented by factory study.

Location.—Washington, D. C.

Date begun.—1913.

Results.—Using the carbonation machine developed during this investigation, a systematic study of the effect of various constituents of malt, vinous, and soft drinks is in progress. A number of carbonated liquids, both natural and artificial, have been studied. The results obtained have been used in the regulation of imports and of domestic commerce in foaming wines, cider, etc. The results also bear upon the use of distilled water in manufacturing carbonated nonalcoholic drinks.

Assignment.—H. E. Patten, H. J. Morgan.

Proposed expenditures, 1916-17.—\$1,735.

Electrochemical Study of the Reactions of Vegetable, Fruit, and Animal Juices:

Object.—To make an electrochemical study of reactions in vegetable, fruit, and animal juices, involving an evaluation of the so-called hydrogen-ion concentration; to study the causes of corrosion of metallic containers; to secure a better understanding of jell formation; and to obtain better preservation of food products.

Procedure.—Necessary physical, electrical, and chemical apparatus of a fixed nature are assembled to carry out electromotive force determinations and electrical conductivity determinations under controlled conditions.

Location.—Washington, D. C.

Date begun.—1913.

Results.—(1) During 1916: The electromotive force of hydrogen (dissolved in palladium) has been measured against various fruit juices and the hydrogen-ion concentration calculated therefrom. Rough preliminary measurements have been obtained for a number of the common fruits. An extended study under more accurately controlled conditions has been made on grapefruit and on oranges to ascertain how their effective free acidity varies with approach to maturity. For certain ranges of acidity the indicator tetrabromphenolsulphonephthalein shows color changes which seem likely to serve as a test of ripening for the sweeter varieties of oranges. This indicator is now being tried out in the field. The purpose here is to secure a test of ripeness or sourness which shall be independent of personal differences in taste. For other varieties of oranges other indicators will be sought which turn color at the proper degree of free acidity to show ripeness. Similar application to maturity studies on other fruits is contemplated.

(2) Prior to 1916: An air thermostat has been installed for the control of temperature to 0.01 of a degree, and hydrogen-electrode cells have been set in place and connected with a delicate potentiometer. A large water thermostat for use with the electrochemical conductivity set and for solubility determinations has been completed.

Assignment.—H. E. Patten, G. H. Mains.

Proposed expenditures, 1916-17.—\$1,900.

Physical Chemical Study of the Reactions of Vegetable, Fruit, and Animal Juices:

Object.—To determine what effect the concentration of individual chemical substances in plant and animal juices has on the keeping qualities of food products; also to determine the chemical conditions which induce jell formation.

Procedure.—The concentration of individual chemical substances in plant and animal juices in their relation to the neutral point between acidity and alkalinity will be determined. The conditions of jell formation and the colloid chemistry involved—more especially the concentrations of alkali or of acid at which the disperse phase aggregates into the jell condition—will be studied.

Location.—Washington, D. C.

Date begun.—1913.

Results.—Preliminary work on the effect of concentration of sugar upon the free acidity in fruit juice is in progress. A special viscosimeter is being designed to

Physical Chemical Study of the Reactions of Vegetable, Fruit, and Animal Juices—Continued.

give the approach of a concentrated juice to jell structure. Pure mercury is very necessary to electromotive-force work and to thermal regulation. In this connection an improved form of automatic mercury purifier and a special electrical vacuum still for mercury have been built. Apparatus for making conductivity water have been made and purchased.

Assignment.—H. E. Patten, H. J. Morgan.

Proposed expenditures, 1916-17.—\$2,000.

Chemistry and Manufacture of Baking Powders:

Object.—To determine the effect of various constituents of baking powders upon their baking efficiency; to study the occurrence of impurities detrimental to health and the analytical methods of estimating them.

Procedure.—This investigation involves the application of equilibria and rate of reaction methods to the chemistry of baking powders.

Location.—Washington, D. C.

Date begun.—1911.

Results.—A synthetic study of the effect of calcium sulphate in phosphate baking powders has been carried out and a report made. A study of the determination of lead in baking powders is in progress.

Assignment.—H. E. Patten, G. H. Mains.

Proposed expenditures, 1916-17.—\$1,365.

Total, Physicochemical Investigations, \$7,000, including \$600 statutory.

MICROBIOLOGICAL INVESTIGATIONS.

(Bacteriological Analyses of Foods and Drugs: Discontinued as a separate project; work previously done under this head will hereafter be covered by specific projects under Microbiological Investigations.)

Cultural Studies of *Penicillium* and *Aspergillus* and Species of Related Genera:

Object.—To identify species of these genera and to study their morphology and physiology and their distribution in nature, with a view to determine which of these species are active in the spoilage of foodstuffs.

Procedure.—Cultures of these organisms from any source are made, especially where found to be factors in the decomposition or fermentation of food and drugs. A comparative study will be made of species and of their physiological activities in their natural substrata.

Location.—Washington, D. C.

Date begun.—1914.

Results.—The following articles have been published: "Effect of Pasteurization on Mold Spores," *Journal of Agricultural Research*, vol. 6, No. 4, April 24, 1916; "*Penicillium Avellaneum*, a New Ascus-Producing Species," *Mycologia*, vol. 7, No. 5, September, 1915; and "An Oxalic-Acid Producing *Penicillium*," *Journal of Biological Chemistry*, vol. 22, No. 2, September, 1915.

Assignment.—Charles Thom.

Proposed expenditures, 1916-17.—\$1,500.

Mycology of Spoilage in Cereal Products:

Object.—To determine the cause of deterioration in food products such as corn meal and flour, with special reference to the part played by microorganisms in such spoilage.

Procedure.—Cultures are obtained from such products in varying stages of deterioration as the basis for identifying significant species. These are inoculated into cereals for further study.

Location.—Washington, D. C.

Date begun.—1914.

Results.—A study of the deterioration of oats, together with an investigation of methods for the chemical detection of the products of incipient decomposition, has been conducted.

Assignment.—Charles Thom.

Proposed expenditures, 1916-17.—\$1,000.

Biological Factors in the Deterioration of Forage and Feeding Stuffs:

Object.—To isolate and identify organisms concerned in the specific forms of spoilage of the food of domestic animals, and to determine the conditions favorable to the activities of such species.

Biological Factors in the Deterioration of Forage and Feeding Stuff—Continued.

Procedure.—Cultures are made from feed in various stages of decomposition. The organisms are isolated, compared, and described, and pure-culture inoculation made for the purpose of studying their relations to decomposition processes.

Cooperation.—The Pathological Division of the Bureau of Animal Industry studies the relation of such feeding stuffs to animal health and nutrition.

Location.—Washington, D. C.

Date begun.—1913.

Results.—Work during the past year in connection with moldy feeding stuffs was limited to occasional examinations of samples. Feeding experiments with a strain of *Bacillus botulinus*, obtained in pure culture, have shown the possibility of producing death in domestic animals under conditions which indicate that this organism is of definite significance in poisoning cases.

Assignment.—Charles Thom.

Proposed expenditures, 1916-17.—\$1,500.

Classification of the Bacteria Occurring in Food Products:

Object.—To determine the characteristic normal and pathological flora of the various food products met with in inspection work.

Procedure.—Characteristic organisms present in each particular form of food are isolated and identified by standard methods.

Location.—Washington, D. C.

Date begun.—1915.

Results.—During the past year the flora of sauerkraut, corn silage, and pickles has been studied. Special attention has been given to the flora of canned sardines and of condensed milk.

Assignment.—Charles Thom.

Proposed expenditures, 1916-17.—\$1,500.

Toxicity of Rhizopus and Other Mucorineæ as a Factor in Food Spoilage and Intoxication by Spoiled Food:

Object.—To determine how generally the toxicity known to be associated with *Rhizopus* is distributed in other members of the group, which is constantly associated with food spoilage.

Procedure.—Pure mold cultures are grown in large quantity and studied chemically and examined pharmacologically. An attempt is made to isolate and identify the toxic substance produced by the growing mold.

Cooperation.—Carnegie Institute of Washington at Cold Spring Harbor, N. Y.

Location.—Cold Spring Harbor, N. Y. (mold growing); Washington, D. C. (chemical and pharmacological work).

Date begun.—1915.

Results.—During the fiscal year 1916 specimens of various strains of mold were received from different localities and found to vary in toxicity. Some were found to be extremely toxic, others less so, and some not at all. 2.5 kilograms of powdered mold filaments were received at Washington and have been treated with various solvents in an attempt to obtain the poisonous principle in pure form. This is soluble in water and is precipitated therefrom by alcohol but in a very impure state. Attempts to eliminate impurities have resulted in destruction of toxicity. It is believed, however, that a method has been found whereby purification can be accomplished, and it is expected that the chemical nature of the toxin will soon be discovered.

Probable date of completion.—1918.

Assignment.—A. F. Blakeslee and A. F. Schulze (Cold Spring Harbor, N. Y.); J. F. Brewster (Washington, D. C.).

Proposed expenditures, 1916-17.—\$2,000.

Soaking of Oysters:

Object.—To determine the legitimate extent to which oysters may be washed or chilled before marketing.

Procedure.—Control experiments under commercial conditions are conducted in cooperation with various firms engaged in the oyster trade.

Cooperation.—Individuals, firms, and State commissions engaged in the study or handling of oysters.

Location.—Bureau field laboratories established for the sanitary inspection of oyster beds.

Date begun.—1914.

Soaking of Oysters—Continued.

Results.—A number of successful prosecutions were brought under the food and drugs act, based on the results secured under this project.

Assignment.—P. B. Parsons.

Proposed expenditures, 1916-17.—\$1,000.

Study of Swelled Canned Foods:

Object.—To determine the types of microorganisms present, and the gaseous products of their growth, responsible for the spoilage and "swells" in canned food products, as an aid in the differentiation of the various forms of spoilage.

Procedure.—Spoiled canned foods are collected and the gases and organisms found in them determined. From information thus gathered spoiled canned products are prepared and the gaseous products formed in the cans under these known conditions determined.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Work under this project has so far been confined to the examination of swelled cans of sardines. An anaerobic, spore-bearing, gas-forming organism, not yet positively identified, has been isolated and is believed to be responsible for the greater part of the swelling of cans of sardines. Apparatus for obtaining the gas from swelled cans has been assembled and is in working condition.

Probable date of completion.—1917.

Assignment.—F. C. Weber, Charles Thom, M. M. Obst.

Proposed expenditures, 1916-17.—\$1,220.

Investigations of the Cleansing of Oysters:

Object.—To determine the length of time necessary to allow oysters to remain in pure water in order to be cleansed of possible contamination from polluted water, and to ascertain the effect of changes in salinity, temperature, and other conditions.

Procedure.—This work involves experiments in the transplanting of oysters from waters of low salinity to waters of high salinity and vice versa; also a study of the cleansing of oysters when transplanted to waters of the same salinity.

Cooperation.—Oyster growers.

Location.—Temporary stations along the Atlantic coast in oyster-producing areas.

Date begun.—1916.

Probable date of completion.—1918.

Assignment.—P. B. Parsons.

Proposed expenditures, 1916-17.—\$2,000.

Chemical Investigations of Phenols Produced by Growing Molds:

Object.—To isolate and determine the nature of phenols produced by growing molds.

Procedure.—The molds will be allowed to grow on suitable nutrients and these will be examined from time to time to determine the optimum period of growth for production of phenols. The phenol will then be isolated, purified, and analyzed, and its physiological action will be studied.

Location.—Washington, D. C.

Date begun.—July, 1916.

Probable date of completion.—1919.

Assignment.—C. L. Alsberg, J. F. Brewster.

Proposed expenditures, 1916-17.—\$750.

Total, Microbiological Investigations, \$12,470, including \$1,060 statutory.

MICROCHEMICAL INVESTIGATIONS.**Microanalysis of Foods and Drugs:**

Object.—To develop microscopical methods of analysis of food and drug products.

Procedure.—Field and laboratory methods are employed as each problem demands.

Location.—Headquarters, Washington, D. C.

Date begun.—1901.

Results.—(1) During 1916: Microscopic examinations of flours were conducted for the purpose of determining the amount of offal and for developing a system for grading. Studies were made of microscopic methods for the quantitative estimation of ingredients in certain mixtures; also a study of pepper shells was made in an effort to develop a method for their detection in ground pepper.

(2) Prior to 1916: Special results were obtained in connection with studies in the detection of artificial coloring in teas; of the manufacture of pork and beans for the purpose of detection of decomposed beans in the finished product; of

Microanalysis of Foods and Drugs—Continued.

malt-sprout manufacture; as to the nature of decomposition in various fruits and the development of methods for its detection; and on method of determination of ergot in rye flour. Investigations were also made of the tomato-sauce industry of Italy, and studies on the currant-packing conditions in Greece and of the egg-breaking and drying industry of the United States were conducted. Publications issued: Bureau of Chemistry Bulletins—66, "Fruits and Fruit Products"; 94, "Studies on Apples"; 100, "Some Forms of Food Adulteration"; 108, "Commercial Feeding Stuffs of the United States"; 110, "Chemical Analysis and Composition of American Honeys"; 117, "Commercial Sicilian Sumac," and 160, "A Study of Nuts with Special Reference to Microscopic Identification"; Department Yearbook articles "The Use of the Microscope in the Detection of Food Adulteration" (1907) and "Decomposition and Its Microscopical Detection in Some Food Products" (1911); an article entitled "Tannin Cells of Persimmons," Bulletin of the Torrey Botanical Club, 1906, and a paper entitled "A Method for the Detection of Color in Tea," reprinted from the Original Communications, Eighth International Commerce of Applied Chemistry, vol. 18, page 301.

Assignment.—B. J. Howard.

Proposed expenditures, 1916-17.—\$3,740.

Studies in the Microscopical Detection of Decomposition in Tomato Products:

Object.—To determine the influence of certain processes of manufacture upon the microscopical characteristics of the product, special attention to be given to the question of the influence of the "finishing" process upon the microscopic count and to the correlation between the amount of decay in tomatoes and the count on the finished product.

Procedure.—Study will be made under factory conditions of samples of tomatoes before pulping, also microscopical studies of the pulp and finished product; and work in cooperation with manufacturers, looking to the sanitary control of the product, will be conducted.

Cooperation.—Tomato-canning establishments.

Location.—Headquarters, Washington, D. C., various canneries, especially in Maryland and Indiana.

Date begun.—1908.

Results.—A better understanding of the causes of high counts in certain products has been obtained and data bearing on the subject collected. As a result of the work there has been developed among some of the packers a sense of the importance of sanitary methods in factory practice, and many factories have discarded in whole or in part practices which resulted in the production of objectionable products due to the use of more or less decomposed materials. As a final result, the class of goods on the market has been much improved. Bureau of Chemistry Circular 68, "Tomato Ketchup under the Microscope," reports some of the results of the work done along this line of investigation early in its history.

Assignment.—B. J. Howard, C. H. Stephenson.

Proposed expenditures, 1916-17.—\$1,000.

Total, Microchemical Investigations, \$4,740, including \$300 statutory.

WATER INVESTIGATIONS.**Study of the Methods of Water Analysis:**

Object.—To devise new methods in water analysis, to improve old methods and unify them, to develop methods for accurately measuring radioactivity, to study the radioactivity of waters, and to study the content of waters in the rarer constituents.

Procedure.—Experimental laboratory work is carried on and the literature and results obtained by coworkers in the same field studied.

Cooperation.—Association of Official Agricultural Chemists, American Public Health Association, American Chemical Society, and others.

Location.—Washington, D. C.

Date begun.—1902.

Results.—(1) During 1916: Investigation of methods for determining iodine and bromine were conducted, also of methods for the determination of strontium, nitrates, and barium and along the line of further perfecting methods for the determination of radioactive materials. The Association of Official Agricultural Chemists' methods for water have been reviewed and prepared for publication. In cooperation with the American Public Health Association, assistance has been rendered in revising the standard methods of analysis.

Study of the Methods of Water Analysis—Continued.

(2) Prior to 1916: The work on water analysis has been brought to a high degree of perfection. The results of the work are published in Bureau of Chemistry Bulletins 91 and 139 and in numerous annual reports of the referee appearing in the proceedings of the Association of Official Agricultural Chemists.

Assignment.—W. W. Skinner, J. W. Sale, W. F. Baughman.

Proposed expenditures, 1916-17.—\$1,400.

Sanitary Bottling of Waters:

Object.—To determine the best and most cleanly methods possible in the handling and bottling of waters.

Procedure.—The efficiency of bottle-washing machinery, the sterilizing and bactericidal efficiency of washing powders and compounds, and the efficiency of various types of sterilizing machinery are studied.

Location.—Washington, D. C.

Date begun.—1913.

Results.—The efficiency of certain methods of cleaning bottles has been determined by both chemical and bacteriological studies, the detergent and bactericidal efficiency of certain proprietary and ordinary washing compounds studied, and the efficiency of some new solutions tested.

Probable date of completion.—1918.

Assignment.—W. W. Skinner, J. W. Sale.

Proposed expenditures, 1916-17.—\$600.

Impurities in Brines and Food Salt:

Object.—To determine the impurities in food salt and their relation to health, to determine the barium chlorid and other impurities in the brines from which food salt is produced, and to determine practicable methods for the removal of such impurities in the manufacture of salt.

Procedure.—Brine and salt are analyzed and, by experiments in the laboratory and in the salt works, the best methods for removing the impurities determined.

Cooperation.—Commercial plants.

Location.—Washington, D. C., Pomeroy, Ohio, and other places.

Date begun.—1913.

Results.—(1) During 1916: As a result of laboratory experiments it was shown that the barium in the Ohio Valley brines could be economically removed in the production of salt. In cooperation with one salt company at Pomeroy, Ohio, the necessary equipment, including four 50,000-gallon settling tanks, dosing tanks, pumps, blowers, pipe lines, etc., was installed. The application of the method was begun in September, 1915, and approximately 60,000 barrels of salt have been produced. The quality of the salt is satisfactory. Some difficulties have been experienced because of the production of scale and sludge, but it is believed that these can be overcome. A report of the application of the method is being prepared for publication. After the completion of the work on the Ohio Valley brines it is proposed to study the impurities in salt from other sources.

(2) Prior to 1916: The results of former work, which was entirely experimental, have been used as the basis of operation and will be published in the completed report.

Probable date of completion.—1918.

Assignment.—W. W. Skinner, W. F. Baughman.

Proposed expenditures, 1916-17.—\$1,200.

Examination of Miscellaneous Waters and Related Products:

Object.—To aid other bureaus and offices in the solving of problems in which the character of water, water supplies, salts, and sewage are factors by the determination of their chemical composition and sanitary condition.

Procedure.—General analytical and research work is conducted.

Cooperation.—Forest Service, Bureau of Biological Survey, Bureau of Fisheries, and Office of Public Roads and Rural Engineering.

Location.—Washington, D. C.

Date begun.—1902.

Results.—During the past year studies were prosecuted as follows: In cooperation with the Bureau of Biological Survey, on the salinity of various waters from Nebraska lakes, in connection with the investigation of a disease of wild ducks; with the Forest Service, to determine the composition of certain soils as a possible cause of sheep poisoning and also the composition of sediments and waters from the various national forests; with the Office of Public Roads

Examination of Miscellaneous Waters and Related Products—Continued.

and Rural Engineering, on the composition of samples of drainage waters and surface efflorescence. The character of the distilled-water supply of the bureau was checked from time to time.

Assignment.—W. W. Skinner, F. B. Furber, C. H. Badger.

Proposed expenditures, 1916-17.—\$2,000.

Total, Water Investigations, \$5,200, including \$960 statutory.

PHARMACOGNOSY INVESTIGATIONS.**Pharmacognosy Investigations:**

Object.—To determine the chemical, physiological, and morphological characteristics of plants and drugs and to devise new and improved methods of analysis.

Procedure.—The usual methods applied in pharmacognostic investigations are followed.

Cooperation.—Bureaus of Plant Industry and Entomology.

Location.—Washington, D. C.

Date begun.—1914.

Results.—(1) A survey of the cramp bark (*Viburnum opulus*) on the market has shown that with one exception all (49) samples consisted of *Acer spicatum*. A paper is being prepared for publication describing simple tests for differentiation.

(2) A study has been made of the relative sensitivity of commercial litmus papers. A preliminary report was made at the 1915 meeting of the Association of Official Agricultural Chemists and at the April, 1916, meeting of the American Chemical Society.

(3) A study has been made of the occurrence of oxalic acid and its salts in foods and spices. A paper on the subject was presented at the 1916 meeting of the American Chemical Society.

(4) A critical review has been made of the proof of the forthcoming U. S. Pharmacopœia IX and an extended report containing corrections and suggestions submitted.

(5) Work on the *Brassicas*, the *Strophanthus* seeds, *Phaseolus* species, and *Jacaranda caroba* has been continued. A paper on *Phaseolus* is being prepared for publication.

(6) Work on cyanogenesis in plants has been continued. A paper, "Cyanogenesis in Plants: Studies on *Tridens Flavus* (Tall Red Top)," appeared in the May, 1916, number of the Journal of Biological Chemistry. The results obtained are considered to be of far-reaching importance, since many statements in the literature concerning the amount of hydrocyanic acid in plants are based on methods which, according to the bureau's experience, can not give the maximum amount of hydrocyanic acid which may be available.

(7) *Coriaria myrtifolia*, which contains a toxic principle, coriamyrtin, has been detected as an adulterant of marjoram, and officials have been notified to exclude from importation all shipments containing it. A paper describing its characteristics is in preparation.

(8) A paper, "Cedrin, a Glucoside from Simaba Cedron," was presented at the December, 1915, meeting of the Society of Biological Chemists. An abstract appeared in the Journal of Biological Chemistry, vol. 24.

(9) A paper on a saponin from *Yucca angustifolia* was presented at the December, 1915, meeting of the Society of Biological Chemists. An abstract appeared in the Journal of Biological Chemistry, vol. 24.

(10) A paper on a saponin from *Yucca radiosa* was presented at the December, 1915, meeting of the Society of Biological Chemists. An abstract appeared in the Journal of Biological Chemistry, vol. 24.

Assignment.—A. Vieboever, C. O. Johns.

Proposed expenditures, 1916-17.—\$12,155.

CATTLE-FOOD AND GRAIN INVESTIGATIONS.**Rice and Rice Products:**

Object.—To obtain knowledge regarding the composition of paddy, hulled, and polished rice and the various mill products of the same; and to determine reasonable standards for rice mill by-products, especially standards for rice bran.

Procedure.—Methods of milling rice and obtaining rice by-products are studied at various mills in Arkansas, Louisiana, South Carolina, and Texas. Samples of known origin are taken and examined. Attempts will be made to obtain

Rice and Rice Products—Continued.

samples of rice by-products prepared under normal factory conditions and under ideal conditions. On the basis of examination, chemical or microscopic standards will be suggested.

Cooperation.—Various mills will furnish samples and prepare by-products under the very best conditions.

Location.—Washington, D. C.

Date begun.—1915.

Results.—A large number of rice mills were visited during 1916 and authentic samples taken and examined. Analytical work is now nearly completed and a standard for rice bran will shortly be suggested. The results of analyses of rice and rice-mill products show the difference in composition between natural brown and polished rice.

Probable date of completion.—1916.

Assignment.—G. L. Bidwell, J. B. Reed, L. H. Bailey, F. W. Liepsner.

Proposed expenditures, 1916-17.—\$500.

Rice Bran and Rice-Bran Oil:

Object.—To study the possibility of extracting oil from rice bran commercially, thereby improving the keeping qualities and feeding value of the bran; also to suggest a procedure to rice millers by which they can ship rice bran, containing no excess hulls, without danger of spoiling.

Procedure.—Samples of bran from three principal varieties of rice will be treated by an expeller process to determine yields and, in a general way, the properties of the resulting oil and cake, especially the keeping qualities of the cake. This is primarily a feed proposition. However, the oil will be submitted to manufacturers, and to the oil, fat, and wax laboratory of the bureau to determine its value.

Location.—Washington, D. C.

Date begun.—1916.

Results.—Too early to report results.

Probable date of completion.—During fiscal year 1917.

Assignment.—J. B. Reed, G. L. Bidwell.

Proposed expenditures, 1916-17.—\$200.

Standards for Cattle Foods:

Object.—To determine standards for malt sprouts, feed barley, mill oats, cottonseed meal, and other cattle foods.

Procedure.—Authentic samples of cattle foods are collected at source and examined, and methods of manufacturing same are studied. On the basis of the results obtained, standards are promulgated from time to time.

Location.—Washington, D. C.

Date begun.—1906.

Results.—(1) During 1916: Analytical work on standards for cottonseed products was practically completed and the results of such analytical work are being studied. The practice of treating smutty barley with lime was studied and a service and regulatory announcement issued. A study was made of oats bleached with sulphur dioxide and a service and regulatory announcement issued. Mills were visited and a study made to correct the branding of mill oats, feed barley, and similar by-products. A report was prepared on same to be used in the enforcement of the food and drugs act.

(2) Prior to 1916: A large amount of work has been performed on establishing standards; mills visited and samples examined; manufacturers shown that added screenings have no place in bran and other flour-mill by-product feeds, with the result that they have entirely changed their method of manufacture; method developed by which added screenings can be detected; tentative standards for malt sprouts promulgated; standard promulgated for poultry foods containing siliceous grit; a large amount of work performed and being performed on establishing standards for cottonseed products.

Assignment.—G. L. Bidwell, J. K. Haywood.

Proposed expenditures, 1916-17.—\$2,000.

Effects of Storage and Transportation on Composition of Corn:

Object.—To determine the effects of storage and transportation on the chemical composition and value of corn.

Procedure.—The problem is being worked out by the Bureau of Plant Industry, samples of corn being sent to the Bureau of Chemistry for analysis.

Cooperation.—Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1910.

Effects of Storage and Transportation on Composition of Corn—Continued.

Results.—Analyses of 200 to 300 samples were made during the past year, and about the same number of samples have been examined each year for the past five years.

Assignment.—J. K. Haywood, G. L. Bidwell.

Proposed expenditures, 1916-17.—\$2,000.

Total, Cattle-Food and Grain Investigations, \$4,700, including \$1,500 statutory.

ORGANIC CHEMICAL INVESTIGATIONS.**Properties of Amino Acids:**

Object.—To isolate, identify, and determine amino acids, as a basis for the study of the chemical aspects of foods in general and spoilage in particular.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Only preliminary work has yet been done on this project.

Assignment.—I. K. Phelps.

Proposed expenditures, 1916-17.—\$2,500.

Nonsugars in Natural Sirups and Crude Sugars:

Object.—To isolate and identify nonsugars.

Procedure.—The constituents of invert sugar will be separated and identified, and after this has been accomplished the method developed will be applied to natural products.

Location.—Washington, D. C.

Date begun.—1914.

Results.—The method for invert sugar has been partially completed. A study of beet sugar and of beet molasses was begun in March, 1916.

Assignment.—I. K. Phelps, W. T. McGeorge.

Proposed expenditures, 1916-17.—\$1,700.

Organic Acids of Nature:

Object.—To isolate, identify, and determine quantitatively the organic acids of nature.

Procedure.—Usual analytical methods are employed to determine the acids in fruits, fruit products, etc.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Study of a method for estimating lactic acid is nearly completed.

Assignment.—I. K. Phelps, H. E. Palmer, H. A. Lepper.

Proposed expenditures, 1916-17.—\$2,400.

Separation and Identification of Alcohols in Food Products:

Object.—To isolate and identify alcohols found in food products.

Procedure.—Fermented products will be studied and the kinds and products of fermentation investigated.

Location.—Washington, D. C.

Date begun.—1915.

Results.—No work was done on this project during the past year.

Assignment.—I. K. Phelps.

Proposed expenditures, 1916-17.—\$1,700.

Study of the Determination of Nitrogen by the Kjeldahl Method:

Object.—To modify the Kjeldahl method for the determination of nitrogen, making it applicable to all substances containing nitrogen, including those on which the present methods will not give accurate results.

Procedure.—Experiments with different classes of organic compounds will be conducted until modifications of the Kjeldahl method are found which will be applicable to them.

Location.—Washington, D. C.

Date begun.—1914.

Results.—A preliminary report was made at the November, 1915, meeting of the Association of Official Agricultural Chemists and a second report at the April, 1916, meeting of the American Chemical Society. Both these reports are in process of preparation for publication.

Probable date of completion.—1918.

Assignment.—I. K. Phelps, H. W. Daudt.

Proposed expenditures, 1916-17.—\$1,700.

Total, Organic Chemical Investigations, \$10,000, including \$720 statutory.

PHARMACOLOGICAL INVESTIGATIONS.

Caffeine Investigations:

Object.—To study the physiological action of caffeine under various conditions, and to determine the effect of this substance on health when contained in beverages or when used in medicine.

Location.—Washington, D. C.

Date begun.—1909.

Results.—Blood sugar has been shown to be increased under the influence of caffeine.

Probable date of completion.—1917.

Assignment.—William Salant.

Proposed expenditures, 1916-17.—\$1,000.

Toxicity and Pharmacology of Oil of Chenopodium:

Object.—To determine the toxicity and pharmacology of oil of chenopodium, with a view to the standardization of the drug.

Procedure.—The physiological action of this drug is determined, including a study of its general toxicity, effect on circulation, respiration, etc.

Location.—Washington, D. C.

Date begun.—1911.

Results.—It has been shown that the substance is toxic and cumulative; that the poisonous effect increases in starvation; circulation and respiration are depressed; irritability of smooth muscle of intestines decreased; that toxicity may be decreased by feeding vegetable oils. An examination of several samples showed variation in activity. It was also found that cardiac depression was produced, as shown in experiments on isolated heart, and that adrenalin and digitalis antagonize depression. Caffeine has no effect or may increase depression caused by oil of chenopodium.

Probable date of completion.—1917.

Assignment.—William Salant.

Proposed expenditures, 1916-17.—\$1,000.

Pharmacology of Zinc and Tin:

Object.—To secure data on the pharmacology of zinc and tin, in order to determine the effect upon health when contained in food products.

Procedure.—The physiological action on animals is determined and compared with the effects of other heavy metals.

Location.—Washington, D. C.

Date begun.—1912.

Results.—(1) During 1916: A study of the toxicity of zinc and tin as compared with nickel shows that nickel is less toxic to smooth muscle. The influence of lead on smooth muscle was also compared with zinc and tin.

(2) Prior to 1916: Diabetes and nephritis have been shown to be produced by zinc salts. The elimination of zinc takes place chiefly in the intestines and only slightly in the urine and bile. It is also stored in bones, muscle, skin, and liver. Diet is an important factor in determining the action of zinc. Tin, like zinc, decreases irritability of smooth muscle but is much weaker. Under certain conditions it may produce nephritis. The metal is stored in the liver, skin, bones, and muscle.

Probable date of completion.—1917.

Assignment.—William Salant.

Proposed expenditures, 1916-17.—\$4,000.

Pharmacological Action of Tartrates and Citrates:

Object.—To investigate the effect of tartrates and citrates on health.

Procedure.—The behavior of these substances in the body is determined by physiological and chemical methods.

Location.—Washington, D. C.

Date begun.—1912.

Results.—(1) During 1916: Citrate is shown to be oxidized in the body. Herbivorous animals oxidize it better than carnivorous. When given by mouth it is oxidized almost entirely in the intestine. If administered subcutaneously or intravenously, it is oxidized by the tissues. Malate, like tartrate, is also oxidized better in herbivorous than in carnivorous animals.

(2) Prior to 1916: It has been determined that nephritis and acute and sub-acute intoxication in different animals are produced by tartrates, that diet is an important factor in determining toxicity, that tartrate is a heart depressant,

Pharmacological Action of Tartrates and Citrates—Continued.

that the depressing effect of citrate on the heart is greater than that of tartrate, and that citrate disappears rapidly from the circulation.

Probable date of completion.—1917.

Assignment.—William Salant.

Proposed expenditures, 1916-17.—\$3,000.

Pharmacological Action of Turpentine:

Object.—To determine the effect of turpentine on health when used in painting and in medicines.

Procedure.—The pharmacological action of turpentine will be studied by experiments on animals.

Location.—Washington, D. C.

Date begun.—1914.

Probable date of completion.—1917.

Assignment.—William Salant.

Proposed expenditures, 1916-17.—\$500.

Physiological Tests of Ergot, Cannabis Indica, Digitalis, etc.:

Object.—To conduct physiological tests of ergot, *Cannabis indica*, digitalis, etc., in order to ascertain the quality of the drugs.

Procedure.—The physiological effect of these drugs is determined by experiments on animals.

Cooperation.—Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1913.

Results.—(1) During 1916: Tests were made on preparations of digitalis purchased on the open market and also on the crude drug. Tests have also been made on ergot, atropine, etc.

(2) Prior to 1916: Physiological studies were made on ergot obtained from various sources.

Assignment.—William Salant.

Proposed expenditures, 1916-17.—\$1,000.

Pharmacology and Toxicology of Lac Dyes:

Object.—To study the pharmacology and toxicology of lac dyes, with a view to determine their effect on health when contained in food products.

Location.—Washington, D. C.

Date begun.—1912.

Results.—Lac dye has been found to be toxic for different animals, and data on elimination of this dye have been obtained.

Probable date of completion.—1917.

Assignment.—William Salant.

Proposed expenditures, 1916-17.—\$500.

Pharmacology and Toxicology of Food Colors:

Object.—To study the pharmacology and toxicity of dyes, in order to determine their effect on health when used to color foods.

Location.—Washington, D. C.

Date begun.—1914.

Results.—(1) During 1916: A large number of dyes were studied and data secured on their physiological action, including their elimination and synthesis in the body. A number of water-soluble dyes and zinc were found to be synergistic. Erythrosin was found to be an exception, as it was antagonistic to zinc.

(2) Prior to 1916: It has been found that fat-soluble dyes are transformed into water-soluble dyes and are eliminated slowly from the body.

Assignment.—William Salant.

Proposed expenditures, 1916-17.—\$4,000.

Total, Pharmacological Investigations, \$15,000, including \$720 statutory.

CARBOHYDRATE INVESTIGATIONS.**Investigations of Maple Products:**

Object.—To investigate methods of manufacture of maple sirup and study the effect of improved apparatus and methods upon the composition of the sirup; to investigate trade and factory methods of refining and packing maple products; to study methods for the detection of adulteration in maple products; and to compile a general index of the trade, including the securing of labels used.

Investigations of Maple Products—Continued.

Procedure.—Information and labels for the general index are secured by inspectors. A study is made of the manufacture of sirup, of the effect of improved apparatus, etc., on its composition, and of trade and factory methods of refining and packing. This information is obtained by means of trips to maple camps and packing houses, where samples are secured and brought to Washington for analysis. All analytical investigations are conducted in the laboratory at Washington.

Cooperation.—Representative producers of pure products and packers of pure and mixed products; State authorities and associations.

Location.—Washington, D. C.

Date begun.—1914.

Results.—During the past year complete information in regard to trade practices and also copies of labels were secured from nearly all of the firms packing maple products. It is hoped to secure the same from the remaining ones within a short time. Investigations were conducted relative to the effect of improved apparatus and methods upon the composition of the sirup, and analyses of 15 samples of extremely light-colored sirups (collected in April, 1916) were made. Some work was done relative to methods of packing sirup, with the object of preventing the formation of mold that sometimes appears in bottled sirup. Some work was conducted on methods for detecting adulteration in maple products, based upon study of the organic acids present.

Probable date of completion.—1917.

Assignment.—S. F. Sherwood.

Proposed expenditures, 1916-17.—\$2,000.

Chemical Investigations of Pure and Adulterated Honey:

Object.—To test methods for determining the adulteration of honey by the addition of cane sugar, commercial invert sugar, or glucose; to investigate granulation and other changes in honey upon storage; to analyze honey-dew and dextrorotatory honeys; to study methods for the detection and estimation of added commercial glucose; and to determine the use and value of this type of honey for food purposes.

Procedure.—The usual laboratory methods are followed.

Cooperation.—Office of Bee-Culture Investigations, Bureau of Entomology.

Location.—Washington, D. C.

Date begun.—1914.

Results.—It has been found that the crystallization of honey can be retarded or prevented by slight increases in the percentage of levulose in the honey. A few preliminary studies on the honey-dew type of honey were carried on during the year.

Probable date of completion.—1919.

Assignment.—C. S. Hudson, S. F. Sherwood.

Proposed expenditures, 1916-17.—\$700.

Candy Investigations:

Object.—To study the physical and chemical changes which occur during the manufacture and keeping of candy.

Procedure.—In order to learn the methods of making the simple and the more complex types of confectionery, visits are made to confectionery factories and experiments are conducted in the laboratory to establish the limits and proportions of ingredients, the temperatures of cooking, and related details.

Cooperation.—Several large candy manufacturers and members of the National Confectioners' Association.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Because of pressure of other work no laboratory investigations were carried out on this project during the past year, but considerable data were accumulated concerning factory methods in the manufacture of confectionery.

Probable date of completion.—1920.

Assignment.—C. S. Hudson, J. Hamilton.

Proposed expenditures, 1916-17.—\$2,000.

Investigations in the Manufacture and Analysis of Fruit Sirups, Jams, Preserves, Jellies, and Marmalades:

Object.—To obtain analyses of pure products and of mixtures of known origin.

Procedure.—Visits are made to large factories manufacturing jams, preserves, jellies, etc., where work is carried on and samples secured for analysis in the laboratory at Washington. Experimental work on the manufacture of the different products is also carried out in the laboratory.

Investigations in the Manufacture and Analysis of Fruit Sirups, Jams, Preserves, Jellies, and Marmalades—Continued.

Cooperation.—Manufacturing firms; Office of Pomological and Horticultural Investigations, Bureau of Plant Industry; States Relations Service.

Location.—Washington, D. C.

Date begun.—1914.

Results.—(1) During 1916: In addition to continuing the work already begun, a study was made of the cause of cloudiness in apple jelly and of the yield of jelly from different varieties of apples, showing quite a variation, depending upon the apple. A study has been made of the utilization of kumquats for a preserve and for a crystallized fruit. Work is in progress in preparing preserved figs for the market, and satisfactory results have been obtained.

(2) Prior to 1916: Trips were made to a large number of jelly, jam, preserve, and marmalade factories, where samples of the various products were made and brought back to Washington for analysis. The processes of manufacture were thoroughly studied. Experiments in manufacturing the various types of products treated in this project were also carried out in the laboratory at Washington, with the result that excellent recipes have been worked out which have given much satisfaction. Much assistance has been given to the various canning clubs organized under the States Relations Service in the Southern States, by attending their annual meetings and giving lectures and demonstrations in jelly, marmalade, and preserve making.

Probable date of completion.—1920.

Assignment.—M. N. Straughn.

Proposed expenditures, 1916-17.—\$3,500.

Preparation of Pure Carbohydrates:

Object.—To find the best methods for preparing the various sugars and other carbohydrates in pure condition.

Procedure.—Investigations are conducted in the laboratory.

Location.—Washington, D. C.

Date begun.—1914.

Results.—(1) During 1916: Improved methods were devised for the preparation of the sugars xylose, cellose, and β -galactose in pure condition. An article entitled "The Preparation of Melibiose" was published in the Journal of the American Chemical Society, vol. 37, No. 12, December, 1915. Considerable progress was made in improving the methods for the isolation of gentiobiose from gentian root.

(2) Prior to 1916: Improved methods were devised for the preparation of the following sugars in pure condition: Raffinose, trehalose, the alpha and beta forms of glucose, mannose, melibiose, and galactose. Data were published in the Journal of the American Chemical Society, vol. 36, No. 10, October, 1914, under the title "The Preparation of Raffinose."

Probable date of completion.—1920.

Assignment.—C. S. Hudson, T. S. Harding, J. M. Johnson, E. P. Clark.

Proposed expenditures, 1916-17.—\$2,500.

Physical and Chemical Constants for Pure Carbohydrates:

Object.—To measure the optical rotation and other properties by which the carbohydrates are distinguished from one another.

Procedure.—Investigations are conducted in the laboratory.

Location.—Washington, D. C.

Date begun.—1914.

Results.—The rotatory powers of the alpha and beta forms of nearly all the sugars have been measured, either directly or by indirect methods, and the work is now in preparation for publication. The following articles on new derivatives of the sugars have been published in the Journal of the American Chemical Society: "A Second Crystalline d-Fructose Pentacetate (α -d-Fructose Pentacetate)," vol. 37, No. 12, December, 1915; "Crystalline β -Methyl Fructoside and Its Tetracetates," vol. 38, No. 6, June, 1916; "The Isomeric Tetracetates of Xylose, and Observations Regarding the Acetates of Melibiose, Trehalose, and Sucrose," vol. 37, No. 12, December, 1915; "Bromoacetylxylose and β -triacetylmethylxyloside," vol. 37, No. 12, December, 1915; and "A Fourth Crystalline Pentacetate of Galactose and Some Related Compounds," vol. 38, No. 6, June, 1916.

Probable date of completion.—1920.

Assignment.—C. S. Hudson, E. Yanovsky, Ralph Sayre.

Proposed expenditures, 1916-17.—\$3,000.

Methods of Analysis for Carbohydrates:

Object.—To test and improve general methods of analysis for carbohydrates and to utilize the selective action of enzymes in new analytical methods.

Procedure.—Investigations are conducted in the laboratory.

Location.—Washington, D. C.

Date begun.—1914.

Results.—(1) During 1916: A new method for the estimation of commercial glucose in sorghum sirup by the use of enzymotic hydrolysis has been worked out, as stated under the project entitled "Investigations in the Manufacture of Sorghum Sirup," and a study of the application of this method to other sirups, etc., has been begun.

(2) Prior to 1916: In conjunction with the project entitled "Physical and Chemical Constants for Pure Carbohydrates," the characteristic acetates of the following sugars have been prepared and their rotatory power measured in confirmation of the data of previous workers: Alpha- and beta-glucose, alpha- and beta-tetracetyl methyl glucoside, beta-lactose octacetate, beta-maltose octacetate, beta-xylose tetracetate, beta-melibiose octacetate, trehalose octacetate, sucrose octacetate, the first pentacetate of galactose, the alpha- and beta-octacetates of cellose, and mannose beta-pentacetate. From these substances there have been prepared as new compounds the following isomeric forms, and their characteristic rotatory powers have been measured: The second, third, and fourth pentacetates of galactose, the alpha-octacetates of lactose and maltose, the alpha-tetracetate of xylose, the alpha-pentacetate of mannose, and the alpha- and beta-pentacetates of fructose. This work has been described in the following publications: "A Comparison of the Optical Rotatory Powers of the Alpha and Beta Forms of Certain Acetylated Derivatives of Glucose," "The Isomeric Octacetates of Lactose," "The Isomeric Alpha and Beta Octacetates of Maltose and of Cellose," "The Isomeric Pentacetates of Mannose," and "Crystalline d-Fructose Pentacetate," all of which were published in the Journal of the American Chemical Society for May, 1915; and the two following papers appeared in the June number of the same journal: "Conversion of Galactose Pentacetate to an Isomeric Form" and "The Existence of a Third Crystalline Pentacetate of Galactose."

Probable date of completion.—1920.

Assignment.—C. S. Hudson, D. H. Brauns, T. S. Harding, J. M. Johnson.

Proposed expenditures, 1916-17.—\$4,000.

(Investigation of the Use of Barium and Strontium in the Manufacture of Sugar: Project completed. This project was undertaken for the purpose of investigating the barium and strontium methods as used in the manufacture of sugar, with the view of determining what amounts, if any, of the barium and strontium remain in the raw and refined sugar; also, provided barium and strontium were present, to determine in what form they occur. Samples of sugar and molasses were collected from a beet-sugar factory using the barium method, and examination made in this laboratory. The results show that where the process is carefully controlled there is no barium left in the sugar or molasses. It was found that the strontium process was not in use either in the United States or Canada, so that it was not possible to get any information regarding it.)

Detection of the Characteristic Carbohydrates in Drug Plants and Food-stuffs:

Object.—To isolate and determine the characteristic sugars in drug plants and foodstuffs, in order that these substances may be used as characteristic tests for the presence or absence of the respective plant material in drugs and foods which come under examination.

Procedure.—Laboratory investigations in organic chemistry.

Location.—Washington, D. C.

Date begun.—1915.

Results.—An analysis was made of the avocado (alligator pear), resulting in the discovery of a new type of sugar. Its properties and chemical nature were determined, and a report on the work is ready for publication. Work is in progress on the configuration of apiose (a sugar present in parsley). An analysis was made of chufa nuts (*Cyperus esculentes*).

Probable date of completion.—1920.

Assignment.—C. S. Hudson, F. B. La Forge.

Proposed expenditures, 1916-17.—\$2,000.

Method of Manufacture and Composition of Commercial Invert Sugar:

Object.—To investigate the method of manufacture and the composition of commercial invert sugar; the information thus obtained to be used for the detection of invert sugar in adulterated honey.

Procedure.—Samples will be obtained from factories of various manufacturers and examined. Samples will probably be obtained also in the open market. Complete chemical analyses will be made.

Location.—Philadelphia, Pa.

Date begun.—1915.

Probable date of completion.—During fiscal year 1917.

Assignment.—C. S. Brinton.

Proposed expenditures, 1916-17.—\$500.

Total, Carbohydrate Investigations, \$20,200, including \$1,200 statutory.

DAIRY INVESTIGATIONS.

(Estimation of the Total Solids of Evaporated Milk by Calculation from Its Specific Gravity and Fat Content: Project completed. About 45 samples of evaporated milk were analyzed for fat and total solids, the specific gravity was taken, and the total solids, obtained by applying the Babcock formula, were compared with the results obtained by drying. The milk was then diluted with an equal weight of water, the specific gravity again taken, and the solids calculated as before. The results obtained on the undiluted milk show that the solids obtained by calculation were always higher (0.2 to 0.4 per cent) than the solids obtained by drying, which indicates that the calculation of the total solids from figures obtained on the undiluted product, in accordance with the practice followed at some factories, gives results that are too high, and that the calculation on the diluted product results in too low a figure. The object of this work was to determine these points and to make the necessary correction.)

Determination of Alkali in Butter:

Object.—To devise methods for the detection of alkali in the manufacture of butter.

Procedure.—Various methods for the detection of alkali will be tested by the usual laboratory methods.

Location.—Washington, D. C., and Denver, Colo.

Date begun.—1913.

Results.—About 75 samples have been examined, the principal determination being the CaO in the salt-free ash and the ratio of the alkalinity of the ash to P_2O_5 in the ash. A large amount of data has been collected, but entirely satisfactory results have not been obtained. It is proposed to accumulate more data on a method worked out in the Dairy Laboratory whereby the relation of the alkalinity of ash to P_2O_5 , using Na_2CO_3 in ashing, is determined. An examination of samples of known history will be made. Some of the results have been prepared for publication.

Probable date of completion.—1917.

Assignment.—L. W. Ferris, H. J. Wichmann.

Proposed expenditures, 1916-17.—\$500.

(Study of Methods for Detecting the Watering of Milk: Project completed. The purpose of this investigation was to ascertain whether it is possible to distinguish between watered milk and genuine milk of abnormally low solids-not-fat content. It was claimed by some investigators that this distinction could be made by determining the freezing point of the milk. Authentic samples of milk from 17 individual cows of different breeds—both morning and evening samples—were examined, complete analyses made, and the freezing point determined. The results obtained show the freezing-point figure to be the most constant one yet found and very valuable in detecting the presence of added water in milk in many cases where ordinary analysis fails. The results of this study have been submitted for publication.)

Study of Artificial Cream:

Object.—To develop, if possible, methods for distinguishing (1) homogenized cream; (2) cream made from sweet unsalted butter and from milk powder and water; and (3) cream made from old unsalted butter, treated in some way with either fresh skimmed milk or with dried milk and water.

Study of Artificial Cream—Continued.

Procedure.—Samples of these artificial creams, prepared in different ways, will be procured and an investigation made to determine whether each sample can be identified by one or more of the following methods or any other method that may develop: (1) Microscopic test; (2) deposit by centrifuging; (3) nitrate test as evidence of added water; (4) CaO in ash and relation of alkalinity of ash to P_2O_5 .

Cooperation.—Creameries.

Location.—Washington, D. C.

Date begun.—July, 1916.

Probable date of completion.—1919.

Assignment.—L. W. Ferris, O. L. Evenson.

Proposed expenditures, 1916-17.—\$1,500.

Total, Dairy Investigations, \$2,000.

BEVERAGE INVESTIGATIONS.**Investigation of the Composition of Foreign Ports and Sherries and Other Wines:**

Object.—To determine the composition of typical samples of wine, including so-called vegetable wines and so-called fruit wines other than grape, which are of known origin and which have been produced under known conditions.

Procedure.—In the case of foreign wines, samples are procured either through the State Department or through the customs officials at the ports of entry. In the case of domestic wines, these will be prepared by or under the supervision of a representative of the bureau and then analyzed.

Cooperation.—Viticulturists of the Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1913.

Results.—Twenty-one samples of port wine, collected through the State Department and through the New York laboratory of the bureau, were analyzed, as were also four samples of sherry secured through a New York importer. Three varieties of *Rotundifolia* grapes, purchased in North Carolina, were made into wine at Charlottesville, Va., the wines being analyzed before fermentation was completed. After proper aging and bottling, these wines will be analyzed again. Samples of port and Madeira wines exhibited at the recent Panama-Pacific Exposition have been procured for analysis.

Probable date of completion.—1918.

Assignment.—H. S. Paine, M. J. Ingle.

Proposed expenditures, 1916-17.—\$2,165.

Study of the Composition of Nonalcoholic Beverages:

Object.—To determine the composition of representative samples the origin and conditions of production of which are known.

Procedure.—A field survey of trade practices with respect to the manufacture of these beverages will be completed, and typical samples produced under the observation of a representative of the bureau will be analyzed. New methods for the analysis of such products will be devised, if necessary.

Cooperation.—Various manufacturers of nonalcoholic beverages.

Location.—Washington, D. C., and the field.

Date begun.—1915.

Results.—A partial survey of trade practices in the carbonated beverage industry, with special study of ginger ale, has been made. Samples of ginger and capsicum ales were made and analyzed and are being stored to note the stability of the flavor.

Probable date of completion.—1918.

Assignment.—H. S. Paine, M. J. Ingle.

Proposed expenditures, 1916-17.—\$1,965.

Investigation of the Composition of Brandies:

Object.—To determine the composition of brandies made in different ways and from various kinds of fruit.

Procedure.—Samples collected under known conditions will be analyzed, and a study of the factors which contribute to the variation in the composition of brandy will be made.

Cooperation.—Various brandy distilleries.

Location.—Washington, D. C., and the field.

Date begun.—1915.

Investigation of the Composition of Brandies—Continued.

Results.—A preliminary survey of the commercial methods of manufacturing brandies has been made. It has been necessary to defer further work on this subject pending completion of the project, "Study of Methods of Analysis of Distilled Liquors." In view of this fact and the large amount of work which will be necessary in investigating the composition of brandies, further work on this project is not contemplated until the fiscal year 1918.

Probable date of completion.—1918.

Assignment.—H. S. Paine.

Proposed expenditures, 1916-17.—No allotment; work temporarily suspended.

Investigation of the Composition of Cordials:

Object.—To determine the composition of representative types of commercial cordials made from fruit and fruit products.

Procedure.—A study of the commercial methods for the manufacture of these products is made, and the samples of cordials prepared from known materials analyzed in accordance with commercial procedure.

Cooperation.—Various cordial manufacturers.

Location.—Washington, D. C., and the field.

Date begun.—1915.

Results.—Information regarding the commercial methods and practices employed in the manufacture of cordials has been obtained, samples of known composition collected, and literature pertaining to the subject reviewed. The examination of samples is approximately half completed.

Probable date of completion.—1917.

Assignment.—H. S. Paine, J. I. Palmore.

Proposed expenditures, 1916-17.—\$1,765.

Investigation of the Composition of Malt Beverages:

Object.—To determine the composition of malt beverages made from various materials.

Procedure.—This project involves a study of the composition of malt liquors made from material including 6-row Pacific-coast barley malt.

Cooperation.—Various breweries and bureau branch laboratories; as associate referee on beer, the Association of Official Agricultural Chemists.

Location.—Washington, D. C., and cities in which breweries are located.

Date begun.—1911.

Results.—The examination of malt liquors made from materials including 6-row barley malt (except Pacific-coast 6-row barley malt) has been completed. The results obtained have been compiled and submitted for publication. Investigation has shown that the amount of 2-row barley malt used in brewing in this country is practically negligible.

Probable date of completion.—1917.

Assignment.—H. S. Paine.

Proposed expenditures, 1916-17.—\$1,200.

Study of Methods of Analysis of Distilled Liquors:

Object.—To improve these methods, especially the methods employed for the determination of fusel oil; and to study the effect of essential oils on the latter determination.

Procedure.—Experimental work will be carried out with the idea of determining the necessary limits of error in existing methods and of improving these methods or of devising new ones.

Location.—Washington, D. C.

Date begun.—1914.

Results.—A review of the literature has been completed and experimental work begun. A tentative method for the determination of fusel oil was devised during the past year, but further work in perfecting the method will be necessary.

Probable date of completion.—1917.

Assignment.—H. S. Paine, J. I. Palmore.

Proposed expenditures, 1916-17.—\$1,125.

(Study of So-Called Wines Prepared from Fruit or Vegetables Other than the Grape: Discontinued as a separate project; included under "Investigation of the Composition of Foreign Ports and Sherries and Other Wines.")

Total, Beverage Investigations, \$8,220, including \$600 statutory.

DRUG INVESTIGATIONS.

Methods of Drug Analysis:

Object.—To develop and study methods of analysis of drug products.

Procedure.—Established methods will be investigated and, if found adequate, will be used; otherwise new methods will be developed.

Cooperation.—Bureau of Plant Industry, State and municipal officials, and Association of Official Agricultural Chemists.

Location.—Washington, D. C.

Date begun.—1907.

Results.—A number of methods of analysis have been worked out and published, including methods for the estimation of acetanilid and phenacetin in admixture, of antipyrin, of caffeine and antipyrin in admixture, of hexamethylene tetramine, and of phenacetin and salol in admixture, and for the determination of santonin.

Assignment.—L. F. Kebler, W. O. Emery, E. K. Nelson.

Proposed expenditures, 1916-17.—\$6,000.

Permissible Variations in Drug Products:

Object.—To determine what should constitute permissible variations in the composition of drug products under different conditions.

Procedure.—The products are subjected to a physical and chemical examination and the results considered in connection with data obtained from material of known composition and manufactured under known conditions.

Location.—Washington, D. C.

Date begun.—1907.

Results.—Permissible variations in tablets, tincture of ginger, and spirits of nitrous ether have been determined.

Assignment.—L. F. Kebler.

Proposed expenditures, 1916-17.—\$3,000.

Elimination of Inert and Objectionable Material in Crude Drugs:

Object.—To study methods of elimination of inert and objectionable material during the process of gathering crude drugs.

Procedure.—The nature and extent of contamination are ascertained by the aid of physical methods and appropriate means of rectification suggested or applied.

Cooperation.—Bureau of Plant Industry and State and municipal officials.

Location.—Washington, D. C.

Date begun.—1907.

Results.—Owing to pressure of other duties no work was carried out on this project during the past year.

Assignment.—A. Viehoveer.

Proposed expenditures, 1916-17.—\$1,500.

Improvement of the Methods of Identification of Alkaloids in Drugs:

Object.—To study the properties of alkaloids and their derivatives for the purpose of improving the methods of identification of these substances in drugs.

Procedure.—Laboratory investigations in organic chemistry.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Work is in progress toward a synthesis of apomorphine, and part of the intermediary compounds have been prepared.

Probable date of completion.—1918.

Assignment.—F. B. La Forge.

Proposed expenditures, 1916-17.—\$1,000.

Examination of the Quality, Purity, and Character of Chemical Reagents for Analytical Work:

Object.—To secure reliable chemicals for the use of the chemists of the bureau.

Procedure.—Chemicals are examined with a view to determine the nature and character of objectionable impurities, if any.

Location.—Washington, D. C.

Date begun.—1903.

Results.—The chemicals supplied to the Bureau of Chemistry have been regularly examined and such reagents as have been found defective rejected. The quality of chemical reagents submitted by contract or otherwise has been greatly improved.

Assignment.—L. F. Kebler, H. E. Buchbinder.

Proposed expenditures, 1916-17.—\$1,620.

Total, Drug Investigations, \$13,120, including \$1,060 statutory.

Total, Enforcement of the Food and Drugs Act, \$808,411, including \$213,850 statutory (regulation, \$632,646; research, \$175,765). This total includes a reserve of \$11,010 for emergencies and new projects; also \$7,500 for a traveling laboratory.

INVESTIGATION OF NAVAL STORES AND DEMONSTRATION OF METHODS OF PRODUCTION.

[Research.]

Investigation of the Grading, Weighing, and Handling of Naval Stores:

Object.—To improve the methods of grading, weighing, and handling of naval stores; to secure the adoption of a definite and universal procedure in grading, weighing, and handling rosin and turpentine, so that the producers may be paid full value for their product and that the buyer may secure delivery of the grade purchased; to serve as referees at the expense of the parties to the transaction in disputed gradings and weighings; and to secure data to serve as a basis for the authoritative adoption of standard grades of naval stores.

Procedure.—The distillation, packing, grading, weighing, and handling of naval stores will be studied and observed at the stills of the producers, at the primary yards of the country, in the hands of the larger buyers, and finally in the hands of the users. Shipments will be followed from producer to user for the purpose of developing improper practices in dealings, if any, with a view to making necessary changes in methods of producing, grading, packing, weighing, and marketing.

Cooperation.—The naval-stores industry; National Oil, Paint, and Varnish Association; Savannah Board of Trade; State naval-stores inspectors of Georgia and Florida, and inspectors of the New York Produce Exchange.

Location.—Headquarters, Washington, D. C., and Savannah, Ga. Experiments will be made at 15 or 20 stills in North Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. Experimental gradings and weighings will be made in New York City, Cincinnati, Ohio, Savannah, Ga., Jacksonville, Fla., and at other large cities and in the hands of users.

Date begun.—1910.

Results.—A simple and accurate method for grading at the still has been devised. Two publications dealing with adulteration, misgrading, methods of examination, standards, and grading at the still have been published. The losses arising from misgrading and adulteration, borne either by the producers or users, have been indicated in these publications. The people are being educated as to the extent of the frauds that have been practiced and in methods of improved grading, handling, marketing, and production.

Grading, weighing, and handling are being studied in the field at points of production, distribution, and consumption. Influences affecting the tare of rosin barrels are being studied for use in the consideration of the proposal to sell rosin by net weight. Information also is being collected on the amount of rosin adhering to the staves. The accuracy of commercial grading of rosin is being investigated, and the extent to which rosin is misgraded and turpentine is adulterated is being widely studied. The indications are that both practices are still widely and largely prevalent. Distillation practices are being studied at many stills, in connection with the grading and weighing work, and many data on cost of various operations have been compiled. Instructions on grading are being prepared, together with improved equipment therefor.

Probable date of completion.—As to research, 1916. Extension work and refereeing in disputes will continue.

Assignment.—F. P. Veitch, C. F. Speh, V. E. Grotlisch.

Proposed expenditures, 1916-17.—\$3,500.

Preparation of Definite Type Samples for Naval Stores:

Object.—To prepare definite and permanent type samples as a basis for trading, and to insure fair, uniform, and simple grading of naval stores.

Procedure.—The colors and variations in color within the type of the type samples commonly employed have been measured. The average of these type colors, with certain obvious and logical exceptions, are adopted as the basis of durable and accurately matched colors of glass held in a frame of the accepted size of the grading samples. These type samples will be deposited with trade bodies having supervision over dealings in naval stores and also will be sold at cost to those who ask for them. Types will be perfected and sets prepared for public distribution.

Preparation of Definite Type Samples for Naval Stores—Continued.

Cooperation.—Naval-stores industry; Savannah Board of Trade; State naval-stores inspectors of Georgia and Florida, and inspectors of the New York Produce Exchange.

Location.—Headquarters, Washington, D. C.

Date begun.—1911.

Results.—Durable, accurate, and practical type samples for rosin have been prepared and distributed for preliminary practical experience and observations. These types have been adopted as official by the Savannah Board of Trade, the New York Produce Exchange, and by other commercial bodies having regulations governing trading in naval stores. Sets of the glass types have been deposited at the chief naval-stores centers, and additional sets are being prepared for distribution to the trade generally.

Probable date of completion.—As to standardization of types, July, 1916. Work in the preparation and verification of types for the benefit of the industry will continue.

Assignment.—C. F. Sammet, C. F. Speh.

Proposed expenditures, 1916-17.—\$1,500.

[Extension.]**Demonstration of Improved Methods or Processes of Preparing Naval Stores:**

Object.—To give instructions and demonstrations in distilling and handling naval stores, in the saving of raw materials now being wasted, and in the making of better products, to the end that the naval-stores industry may be conducted on an economical basis.

Procedure.—Demonstration of improved procedures in naval-stores operations will be conducted by experienced department agents.

Cooperation.—Naval-stores producers throughout the Southern States.

Location.—Headquarters, Washington, D. C. Demonstrations will be made in Georgia, North Carolina, South Carolina, Florida, Alabama, Mississippi, Louisiana, and Texas.

Date begun.—July, 1916.

Assignment.—F. P. Veitch, C. F. Sammet, C. F. Speh.

Proposed expenditures, 1916-17.—\$5,000.

Total, Investigation of Naval Stores and Demonstration of Methods of Production, \$10,000 (research, \$5,000; extension, \$5,000).

BUREAU OF SOILS.

GENERAL ADMINISTRATION.

Office of Chief of Bureau:

Object.—General administration, supervision, and direction of the activities and operations of the bureau.

Cooperation.—Other bureaus of the department, other departments, and State institutions.

Location.—Washington, D. C.

Date begun.—1894.

Assignment.—Milton Whitney.

Proposed expenditures, 1916-1917.—\$5,400.

Office of Chief Clerk:

Object.—The chief clerk is charged with carrying out the directions and policies of the chief of bureau, as these relate to supervision and control of the clerical work, including the handling of correspondence and mail, stenographic and messenger service, and property and supplies.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—A. G. Rice.

Proposed expenditures, 1916-17.—\$15,460. •

Accounts:

Object.—To supervise and keep proper records of all financial operations of the bureau, issue purchase requisitions, make administrative examinations of all accounts and prepare travel authorizations, pay rolls, estimates, and such financial reports as may be required from time to time.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—C. A. Wolfe.

Proposed expenditures, 1916-17.—\$4,400.

Editorial Work:

Object.—To read for the chief of bureau all manuscripts submitted for publication, edit or rewrite such manuscripts as may be necessary to bring them into harmony with the bureau's policy, compile data for use of the soil-survey field men, read and correct proof, and assist in the preparation of specifications for the lithographic reproduction of maps and in the proofreading of the same.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—Chas. H. Seaton.

Proposed expenditures, 1916-17.—\$8,600.

Supplies:

Object.—To supervise and distribute all supplies and equipment purchased for field, laboratory, and office use and record the same.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—J. F. Pevare.

Proposed expenditures, 1916-17.—\$5,500.

Files and Records:

Object.—To index and file all correspondence pertaining to the operations of the bureau.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—H. A. Donovan.

Proposed expenditures, 1916-17.—\$2,600.

Total, General Administration, \$41,960, including \$37,960 statutory.

[Research.]

SOIL CHEMICAL INVESTIGATIONS.

Supervision:

Object.—To direct the chemical investigations of soils and to supervise the routine laboratory and clerical work necessary for the proper conduct of these activities.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—E. C. Shorey.

Proposed expenditures, 1916-17.—\$2,000.

Mineral Nature of Agriculturally Important American Soils:

Object.—To determine predominating minerals or those which characterize soil types, with a view to determine the origin, process of formation, and relations of these types.

Procedure.—Application of petrographic methods as outlined in Bureau of Soils Bulletin 91, or new methods devised for the purpose.

Location.—Washington, D. C.

Date begun.—1908.

Results.—(1) During 1916: The minerals predominating in a number of soil types have been determined and a special study made of the distribution of lime-bearing minerals in 31 soil types.

(2) Prior to 1916: Methods have been perfected and minerals in a large number of soils determined and the data made available for this bureau and outside institutions.

Assignment.—W. H. Fry.

Proposed expenditures, 1916-17.—\$1,420.

Routine Microscopic Work:

Object.—Routine examination of soils and other materials submitted by other divisions of this bureau and other institutions.

Location.—Washington, D. C.

Date begun.—1915.

Results.—(1) During 1916: A large number of samples have been examined, especially samples supposed to contain potash submitted by the Division of Fertilizer Resources.

(2) Prior to 1916: The microscopic examination of miscellaneous samples generally identifies them and obviates chemical analysis in many cases.

Assignment.—W. H. Fry.

Proposed expenditures, 1916-17.—\$920.

Absorption by Soils:

Object.—To determine the effect on soils of the addition of soluble substances and the mutual effects of one soluble substance in the presence of another; and to determine the fixation of fertilizer salts by soils, the physicochemical effects on the soil, and the relation of soluble salts to changes in tilth.

Procedure.—Percolation and adsorption studies with fertilizer salts, lime, etc., and soils of different texture.

Location.—Washington, D. C.

Date begun.—1905.

Results.—It has been shown that the presence of a second solute does affect the absorption of a first solute by a soil and that the effects are specific and characteristic and not due to a general property or properties of the class of solutes.

Assignment.—E. C. Shorey.

Proposed expenditures, 1916-17.—No allotment; work temporarily suspended.

Lime Phosphate Investigations:

Object.—To investigate the nature of the lime phosphates occurring naturally in soils and produced by the application of phosphatic fertilizers.

Procedure.—The phase-rule methods are applied to the investigation of the solutions and the solid lime and iron phosphates formed in soil. Specially refined analytical methods must be developed for this case. The solid lime-iron phosphates will be studied. The nature of the liquid phase and the solid phases in the systems and the lime-iron water are determined under conditions paralleling those obtaining in the soil. Efforts are being made to develop laboratory procedures not yet known for carrying out this investigation.

Location.—Washington, D. C.

Date begun.—1914.

Lime Phosphate Investigations—Continued.

Results.—The nature of solid phosphates of lime, magnesia, and iron in contact with free solutions has been determined. Similar problems in connection with very dilute solutions and for soil water have been investigated. Various basic lime phosphates have been prepared for a continuation of the investigation by fusion methods, and improved analytical methods, necessary to the investigations, have been worked out. Appropriate analytical methods have been found in part.

Assignment.—E. C. Shorey.

Proposed expenditures, 1916-17.—No allotment; work temporarily suspended.

Inorganic Composition of Soils:

Object.—To determine the inorganic composition of important soil types.

Procedure.—The collection of large samples from surveyed areas by field men familiar with the type, with careful handling to prevent contamination, followed by careful laboratory analyses of the samples.

Location.—Washington, D. C., and field assignments.

Date begun.—1911.

Results.—(1) During 1916: A number of soil types have been analyzed and, where a type was represented by two or more samples, certain points of similarity in chemical composition have been found.

(2) Prior to 1916: A number of soils have been analyzed for all the elements for which reliable methods were available. Chromium, vanadium, rare earths, zirconium, barium, strontium, lithium, and rubidium were found in all soils examined for them. Results published in Department Bulletin 122.

Assignment.—W. O. Robinson, L. A. Steinkoenig, R. F. Gardiner, W. B. Pope, C. F. Miller.

Proposed expenditures, 1916-17.—\$7,360.

Ash Composition of Important Crop Plants:

Object.—To determine what elements that have been found in soils are present in plant ash, especially the rarer elements, and the relative amounts of these in the ash.

Procedure.—Analysis of plants grown on soils the composition of which is known.

Location.—Washington, D. C., and field assignments.

Date begun.—1912.

Results.—(1) During 1916: Vanadium, present in nearly all soils, has not been found in plants grown on these soils. Manganese has been found present in the ash of some plants in larger quantity than any other element. Aluminum has been found in the ash of some plants in appreciable quantity.

(2) Prior to 1916: It appears that rubidium is often present in comparatively large amounts and that the number of elements which can be recognized is always large. Analytical methods are being perfected.

Assignment.—W. O. Robinson, C. F. Miller, L. A. Steinkoenig.

Proposed expenditures, 1916-17.—\$460.

Hydrolytic Decomposition of Soil-Forming Minerals:

Object.—To study the action of water and such substances as may exist in the soil solution upon the decomposition and degradation of soil minerals and the possible synthesis of new mineral species.

Procedure.—The work involves chemical studies of hydrolysis products when water acts on minerals, under soil conditions; chemical and microscopic studies of residues; studies of solutions yielded by soil minerals under controlled conditions; field investigations as to changes in minerals from solid rock to soil.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—E. C. Shorey.

Proposed expenditures, 1916-17.—\$1,960.

Routine Chemical Laboratory:

Object.—To make chemical analyses of soils, waters, and similar materials for the bureau and other bureaus of the department and properly accredited parties.

Location.—Washington, D. C.

Date begun.—1901.

Results.—Analytical data provided for various subactivities of the bureau and outside institutions.

Assignment.—J. G. Smith.

Proposed expenditures, 1916-17.—\$4,240.

(Methods of Determining Nitrogen in Soils and Fertilizers: Discontinued as a project under Soil Chemical Investigations; one phase of the work to be continued under Investigations of Fertilizer Resources, project "Fertilizer Value of Fertilizer Materials.")

Relation of Analytical Data to Soil Productivity:

Object.—To make a critical comparison of existing analytical data for soils of known productivity.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Preliminary work only.

Assignment.—E. C. Shorey.

Proposed expenditures, 1916-17.—No allotment; work temporarily suspended.

Liming of Soils:

Object.—To determine the effects of liming and a proper basis for the practice of liming soils.

Procedure.—The physicochemical changes produced in soil by liming will be investigated by laboratory methods. Biological changes are not to be studied specifically; but it is planned, when the laboratory studies have been developed to the point where the results can be utilized in field observations, to seek the assistance of the Bureau of Plant Industry and State organizations.

Location.—Washington, D. C., and field assignments.

Date begun.—1914.

Results.—Preliminary work on the forms in which lime is present in a number of soil types.

Assignment.—E. C. Shorey, J. G. Smith, W. Hazen.

Proposed expenditures, 1916-17.—\$3,090.

Total, Soil Chemical Investigations, \$21,450, including \$840 statutory.

[Research.]

SOIL PHYSICAL INVESTIGATIONS.

Supervision:

Object.—To direct the physical investigations of soils and to supervise the routine laboratory and clerical work necessary to their proper conduct.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—R. O. E. Davis.

Proposed expenditures, 1916-17.—\$2,865.

Designing, Construction, and Standardization of Instruments:

Object.—To assist the activities of the bureau by furnishing or standardizing physical instruments.

Location.—Washington, D. C.

Date begun.—1901.

Results.—Assistance rendered other activities.

Assignment.—C. J. Crawley.

Proposed expenditures, 1916-17.—\$1,700.

Physical Examination of Soils:

Object.—To determine quantitatively the mechanical separates for an expression of the textural characteristics of soils; to investigate the physical composition of soils, and to determine the relation of the different components to the physical condition of the soil.

Procedure.—Soil particles are separated according to size of grains, as described in the routine methods outlined in Bureau of Soils Bulletin 84. Soils are separated into their components by centrifuging, sedimentation, and filtration, and the physical properties of the separates studied. Especial attention will be given the smallest sized particles and the portions separated by filtration. As some of these are present in small amounts, the separation will involve handling several tons of material.

Location.—Washington, D. C.

Date begun.—1901.

Assignment.—L. B. Olmstead, W. B. Page, C. R. Wagner.

Proposed expenditures, 1916-17.—\$5,740.

(Soil Pressure: Discontinued as a separate project; included under "Soil Stresses and Strains.")

(**Translocation of Soil Particles:** Discontinued as a separate project; included under "Soil Stresses and Strains.")

Soil Stresses and Strains:

Object.—To determine the magnitude of the stresses in the soil induced by changes in moisture content or by the application of loads on the soil, and to observe relative movements of large and small particles under alternate wetting and drying.

Procedure.—Measurements are made in the laboratory of stresses produced by the wetting of dry soils at minimum volume. Effects in soil separates and of colloidal matter are being investigated. Relative rates and directions of movement of soil particles are measured.

Location.—Washington, D. C.

Date begun.—1913.

Results.—(1) During 1916: Quantitative measurements of stresses in various soil types and improvements in method and technique have been made. Observations have been made on the relative movement of different sized soil particles.

(2) Prior to 1916: "Natural packing" has been explained; the interchange of soil and subsoil material shown to be continuous; and clodding, the phenomena of soil drainage, etc., elucidated.

Assignment.—L. B. Olmstead, L. H. Greathouse.

Proposed expenditures, 1916-17.—\$425.

Soil Erosion:

Object.—To investigate causes for and control of erosion in soils in different types and under various climatic conditions.

Procedure.—Field examinations are to be made of existing conditions, supplemented by laboratory examinations of soils.

Location.—Washington, D. C., and field assignments.

Date begun.—1913.

Results.—(1) During 1916: An examination of the physical properties of soils especially subject to erosion has been begun.

(2) Prior to 1916: The various types of erosion in Southern and Pacific Coast States have been investigated, causes determined, and preventive and remedial methods critically examined. Publications: "Soil Erosion in the South," Department Bulletin 180; "The Economic Waste from Soil Erosion," Department Yearbook, 1913.

Assignment.—R. O. E. Davis.

Proposed expenditures, 1916-17.—\$775.

Movement of the Soil Solution:

Object.—To investigate the relation of surface texture to movement of the soil solution, with a view to determine the general laws of distribution of soil moisture; to utilize the Wheatstone bridge or other instruments in estimating the moisture content of soils.

Procedure.—The movement of the soil solution within the soil is determined by the study of the moisture equilibrium in different layers of soil. Search is made for some physical property of soils which bears a quantitatively measurable relation to the moisture content. Heat conductivity relationships will be investigated.

Location.—Washington, D. C.

Date begun.—1901.

Results.—(1) During 1916: Continued efforts have been made to work out a practical instrument mainly on the basis of a slide-wire bridge.

(2) Prior to 1916: The general law has been deduced and verified experimentally: distribution of rainfall deduced theoretically and confirmatory experimental data obtained; data collected on the distribution of moisture in the soil and on methods for determining the critical moisture content.

Assignment.—R. O. E. Davis, L. B. Olmstead.

Proposed expenditures, 1916-17.—\$1,050.

(**Soil Hygrometer:** Discontinued as a separate project; combined with "Movement of the Soil Solution.")

Absorption by Soils:

Object.—To determine the effect of various substances upon salts in the fixation of fertilizer constituents by soils, and to study the underlying causes of gases and substances in the soil solution.

Location.—Washington, D. C.

Date begun.—1901.

Absorption by Soils—Continued.

Results.—General laws have been deduced in connection with chemical investigations. Methods are being worked out and apparatus devised.

Assignment.—L. H. Greathouse.

Proposed expenditures, 1916-17.—\$1,150.

Soil Temperatures:

Object.—To investigate heat conductance of soils and the relation of temperature and solar radiation to soil conditions.

Procedure.—The work involves obtaining complete continuous records of temperatures at various depths of soil, together with complete records of solar and sky radiation.

Location.—Washington, D. C., and Arlington Farm, Va.

Cooperation.—Weather Bureau, which furnishes records of solar radiation at regular intervals.

Date begun.—1901.

Results.—(1) During 1916: A method for obtaining continuous records has been determined.

(2) Prior to 1916: General laws as influenced by texture and moisture content have been investigated; advice based upon experimental examination given for a number of special cases met in actual practice by parties seeking assistance from the bureau.

Assignment.—R. O. E. Davis, L. B. Olmstead, L. H. Greathouse.

Proposed expenditures, 1916-17.—\$935.

Soil Aeration:

Object.—To investigate changing conditions of soil atmosphere and their effect on productivity.

Procedure.—Study of the composition of soil atmosphere and its movements as influenced by barometric pressure, temperature, texture, and tillage.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1901.

Results.—(1) During 1916: Methods and apparatus have been devised.

(2) Prior to 1916: Observations on the absorption and retention of carbon dioxid have been made in connection with other subactivities.

Assignment.—L. H. Greathouse.

Proposed expenditures, 1916-17.—\$875.

Total, Soil Physical Investigations, \$15,515, including \$3,290 statutory.

[Research.]

INVESTIGATIONS OF FERTILIZER RESOURCES.**Supervision:**

Object.—To direct the investigations of the fertilizer resources of the United States and to supervise the routine laboratory and clerical work necessary for their proper conduct.

Location.—Washington, D. C.

Date begun.—1911.

Assignment.—Frederick W. Brown.

Proposed expenditures, 1916-17.—\$4,000.

Extraction of Potash Salts from Kelp:

Object.—To investigate and demonstrate on a commercial scale the practicability and economic value of various methods of extracting potash salts from kelp.

Procedure.—A plant will be erected and operated on the Pacific coast to experiment on a commercial scale with various processes for recovering potash from kelp and to demonstrate whether or not, under normal conditions, potash can be recovered from this source in competition with potash from other sources. With the special appropriation available this year, it is proposed to proceed with this project on a scale that will furnish accurate cost data for commercial practice.

Location.—Washington, D. C., and in the field.

Date begun.—1913.

Results.—(1) During 1916: Much data were collected on mechanical equipment necessary for handling kelp by various processes and laboratory work was carried on both with flocculation of green kelp and with carbonization of dried kelp.

Extraction of Potash Salts from Kelp—Continued.

(2) Prior to 1916: The presence of potash in kelp was shown, beds were surveyed and charted, many analyses of kelp were made, and several methods of extraction were experimented with.

Assignment.—Frederick W. Brown, J. W. Turrentine.

Proposed expenditures, 1916-17.—\$175,000.

Effect of Harvesting and Other Factors on the Growth of Kelp:

Object.—To determine the effect of different methods of harvesting on the growth of kelp.

Location.—Washington, D. C., and La Jolla, Cal.

Date begun.—1912.

Results.—(1) During 1916: Continued observation of the factors governing growth of kelp was made, with reports on the operations of commercial plants now at work on the beds.

(2) Prior to 1916: It was shown that harvesting kelp under certain conditions induced increased growth, that fresh water streams have little influence on the beds, and that storms frequently destroy the beds temporarily.

Assignment.—W. C. Crandall.

Proposed expenditures, 1916-17.—\$360.

Production of Potash from Feldspar and Other Mineral Sources:

Object.—To determine commercially possible methods for utilizing feldspar, alumite, natural brines, etc., as sources of potash for fertilizer production.

Procedure.—The practicability of recovering potash from mineral sources is being investigated by various laboratory methods.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1912.

Results.—(1) During 1916: Work on feldspar was suspended during the current year, but this work will be revived about July 1, 1916; preliminary work on the extraction of potash from Salt Lake brines was carried on.

(2) Prior to 1916: Experiments have shown that it is possible, when operating according to the procedure outlined, to completely volatilize the potash from feldspar at the temperatures used in cement manufacture and that the residue obtained has the composition required for Portland cement. Experiments have also shown that when feldspar and lime in proper proportions for cement are treated under pressure about 95 per cent of the potash content is rendered soluble as caustic potash.

Assignment.—W. H. Ross, A. R. Merz.

Proposed expenditures, 1916-17.—\$2,750.

Fertilizer Value of City and Trade Wastes:

Object.—To determine the amount and value of city and trade wastes as sources of commercial fertilizer material.

Procedure.—Inspection of various municipal disposal plants are made, analyses made of samples collected, and a study of practical methods of preparing garbage and other tankage undertaken.

Cooperation.—Municipal officers of various cities.

Location.—Washington, D. C., Arlington Farm, Va., and field assignments.

Date begun.—1913.

Results.—(1) During 1916: A new method of rendering garbage was devised and tested on a laboratory scale with most promising results. A large amount of data on city and trade wastes was collected, and publications on these subjects are now in preparation.

(2) Prior to 1916: The more important garbage-disposal plants in the country have been visited and data for comparing the relative value of different processes collected. An investigation of the garbage of Washington, D. C., was made in cooperation with the municipal authorities to determine the most economical methods of disposal and utilization.

Assignment.—J. W. Turrentine, W. J. O'Brien.

Proposed expenditures, 1916-17.—\$2,500.

Fertilizer Value of Nitrogenous Materials:

Object.—To determine the actual fertilizer value, by chemical and other methods, of the various fertilizer materials.

Procedure.—The various nitrogenous fertilizer materials will be subjected to analyses in the laboratory by the several conventional methods of analysis and the relative availability of their nitrogen studied, special attention being given to the effect of soil types on availability. The effect on availability of the various commercial methods of processing will also be studied.

Fertilizer Value of Nitrogenous Materials—Continued.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1914. This work is part of a project entitled "Methods of Determining Nitrogen in Soils and Fertilizers," carried heretofore under Soil Chemical Investigations. No work has yet been done on the fertilizer side of this project.

Assignment.—J. W. Turrentine, J. P. Schroeder.

Proposed expenditures, 1916-17.—\$3,000.

Fixation of Nitrogen by Catalytic Processes:

Object.—To investigate methods of fixing nitrogen by the aid of catalytic reagents, with a view to increase the efficiency of known methods and to devise new ones.

Procedure.—Laboratory experiments will be made to test the comparative merits of different methods, their relative efficiencies, and their efficiency as compared with other methods of nitrogen fixation.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1916.

Assignment.—J. W. Turrentine, W. J. O'Brien, H. Bryan.

Proposed expenditures, 1916-17.—\$4,000.

Fixation of Atmospheric Nitrogen:

Object.—To investigate new processes of fixing nitrogen by reduction methods.

Procedure.—Studies are made of the use of phosphate rock and of feldspar in the fixation of atmospheric nitrogen by means of electrical energy, with a view to obtain in one operation two or more of the fertilizing elements in soluble form.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1913.

Results.—(1) During 1916: An electric furnace with absorption tower has been installed at the Arlington Farm and numerous experimental runs made, with the object of volatilizing phosphoric acid and fixing nitrogen in one operation.

(2) Prior to 1916: Results of preliminary experiments (Journal of Industrial and Engineering Chemistry, vol. 5) have shown that the potash in feldspar can be completely volatilized when treated according to the procedure outlined and that considerable fixation of nitrogen takes place in the residue at the same time.

Assignment.—W. H. Ross, A. R. Merz, J. N. Carothers, H. Bryan, P. J. Fox.

Proposed expenditures, 1916-17.—\$6,500.

Extraction of Phosphoric Acid from Natural Phosphates:

Object.—To compare the sulphuric acid and electrical methods of extracting phosphoric acid from natural phosphates and to devise improvements in these methods.

Procedure.—This work involves a study of the volatilization of phosphoric acid from phosphate rock by electrical and other forms of heat energy, a comparison of the efficiency of methods devised with the sulphuric-acid method or improvements in the latter method, and an investigation of the most economical methods of separating phosphoric acid from solution.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1913.

Results.—(1) During 1916: The Arlington Farm laboratory has been equipped with apparatus on a semicommercial scale to experiment with the volatilization of phosphoric acid, and numerous experimental runs have been made.

(2) Prior to 1916: A possible improvement in the sulphuric-acid method for preparing phosphoric acid has been devised, and an investigation has been made of a method of separating phosphoric acid from solution, as obtained in either the sulphuric acid or electrical methods, by precipitating it by means of ammonia in the form of ammonium phosphate. A study of the best conditions under which this can be brought about is in progress.

Assignment.—W. H. Ross, W. H. Waggaman, J. N. Carothers, H. Bryan.

Proposed expenditures, 1916-17.—\$4,000.

Phosphate Industry of the United States:

Object.—To investigate the sources, quantity, and production of phosphate rock, its manipulation for the fertilizer industry, the relative merits of the products obtained by the several manipulations, and other factors necessary to determine the cost to the farmer and to inform him concerning changing conditions.

Procedure.—Consultation with manufacturers and consumers of phosphate-carrying materials by correspondence and in person; visiting and consulting officials of State colleges and experiment stations and conducting laboratory investi-

Phosphate Industry of the United States—Continued.

gations in Washington, with a view to ascertain the availability and fertilizer value of finely ground raw phosphate rock and other forms of phosphate fertilizer.

Location.—Washington, D. C., and field assignments.

Date begun.—1911.

Results.—(1) During 1916: A summary of conditions for the year has been made and published; an investigation of the methods of manufacturing phosphate fertilizers made, and a publication on this subject issued; an improved method of producing sulphuric acid for use in manufacturing superphosphates devised and published; the fertilizer value of ground phosphate rock investigated and a publication on the subject in preparation.

(2) Prior to 1916: Statistics on phosphate deposits, production, and consumption have been collected for some years; reports on the deposits of Tennessee, Kentucky, Arkansas, and South Carolina published; investigations made with a view to render the slag produced by iron and steel furnaces available for fertilizer purposes, and methods for utilizing this waste suggested in two publications.

Assignment.—W. H. Waggaman.

Proposed expenditures, 1916-17.—\$2,750.

(Phosphate Deposits in Virginia: Project completed. Analyses of samples from Virginia have been made and a full report is in preparation. Field inspection and laboratory examination of samples show some economic possibilities. Publications: "A Possible Commercial Utilization of Nelsonite," *Journal of Industrial and Engineering Chemistry*, vol. 5, 1913.)

Concentration of Low-Grade Phosphates:

Object.—To determine a method of conserving mine wastes.

Procedure.—Mechanical and chemical methods of separating phosphoric acid from impurities with which it is associated in the material at present discharged on the waste heaps are followed.

Location.—Washington, D. C., and field assignments.

Date begun.—1913.

Results.—Some preliminary results have been obtained from the treatment of hard rock-phosphate waste which show that a partial separation of the phosphoric acid is mechanically practicable.

Assignment.—W. H. Waggaman.

Proposed expenditures, 1916-17.—\$3,500.

Production of Concentrated Fertilizer Products:

Object.—To investigate the possibility of producing combinations of nitrogen, phosphorus, and potash, or combinations of any two of these elements, by methods which may make it possible to use such compounds for fertilizer purposes.

Procedure.—Laboratory experimentation will be carried on with various methods of combining or mixing the elements ordinarily used for fertilizers, and the more promising of these methods will be tried out on a somewhat larger scale.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1915.

Results.—Several very promising methods for producing compounds of the fertilizer elements have been worked out in the laboratory, and apparatus is now being installed to try these methods out on a larger scale.

Assignment.—W. H. Ross, A. R. Merz, J. N. Carothers.

Proposed expenditures, 1916-17.—\$1,750.

Production of Raw Materials in the United States for Fertilizer Purposes:

Object.—To obtain accurate and authentic data, by correspondence with producers and by occasional visits to mines and factories, regarding available or partially available resources.

Cooperation.—Miners and manufacturers.

Location.—Washington, D. C., and field assignments.

Date begun.—1912.

Results.—(1) During 1916: A trip was made to several large cities to secure data on the supply, value, and distribution of stable manure.

(2) Prior to 1916: Summaries of available raw materials have been made and kept up to date.

Assignment.—C. C. Fletcher.

Proposed expenditures, 1916-17.—\$1,000.

(**Extraction of Potassium Salts from Natural Brines:** Discontinued as a separate project; included under "Production of Potash from Feldspar and Other Mineral Sources.")

Analysis of Samples:

Object.—To examine samples of materials which give promise of value for fertilizer use.

Procedure.—Laboratory examination is made of samples submitted by private individuals or secured through the field force of the bureau.

Location.—Washington, D. C., and Arlington Farm, Va.

Date begun.—1911.

Results.—A large number of samples have been analyzed, furnishing chemical data as to fertilizer values of the materials examined to the various subactivities of the bureau and outside organizations and individuals. The information so disseminated has led to the utilization of supplies of fertilizer materials not heretofore used and has undoubtedly prevented the expenditure of large sums of private capital in the attempted exploitation of materials that have no value as a fertilizer. This work is part of the project, "Routine Chemical Laboratory," heretofore carried under Soil Chemical Investigations. So much of this routine analysis as has to do with fertilizers has been transferred to the Division of Investigations of Fertilizer Resources.

Assignment.—W. G. Ross, A. R. Merz, J. A. Cullen.

Proposed expenditures, 1916-17.—\$1,400.

Total, Investigations of Fertilizer Resources, \$212,510, including \$1,910 statutory.

[Research.]

SOIL-SURVEY INVESTIGATIONS.

Supervision:

Object.—To plan and direct all field activities connected with soil-survey investigations, conduct correspondence and supervise general office work, study soil development, correlation, and classification in the field, and make recommendations on the final correlation of soils.

Cooperation.—Other bureaus of the department and State organizations.

Location.—Washington, D. C.

Date begun.—1898.

Assignment.—Curtis F. Marbut.

Proposed expenditures, 1916-17.—\$13,250.

Soil Surveys—Detail and Reconnoissance:

Object.—This work comprises the surveying, mapping, and classifying of the soils of important areas in different parts of the country; the preparation of reports containing descriptive matter relating to the soils, their character, origin, and value for crops, and to the agricultural conditions found in each area surveyed; and the preparation of maps showing the distribution of the soils. The purpose is to acquire a knowledge of the soils of the United States and make it available for use by other bureaus and departments, agricultural colleges, experiment stations, and others engaged in the development of agricultural interests.

Results.—The following areas were completed during the fiscal year 1916:

Alabama: Lowndes, Monroe, Pickens, and Wilcox Counties.

Arkansas: Craighead, Hempstead, and Yell Counties.

California: Healdsburg, Los Angeles, and Santa Ana detail areas; and Lower San Joaquin Valley reconnoissance area.

Delaware: Newcastle County.

Florida: Hillsborough County.

Georgia: Brooks, Crisp, Meriwether, Richmond, and Wilkes Counties.

Idaho: Latah County and Minidoka Project.

Indiana: Grant, Stark, Wells, and White Counties.

Iowa: Clinton, Scott, Sioux, and Van Buren Counties.

Kansas: Cowley County.

Kentucky: Jessamine County.

Louisiana: Rapides Parish.

Maine: Cumberland County.

Mississippi: Hinds and Lee Counties.

Missouri: Buchanan, Newton, Ripley, and St. Francois Counties.

Nebraska: Dawes, Polk, Richardson, and Washington Counties.

New Jersey: Camden area.

Soil Surveys—Detail and Reconnoissance—Continued.

New York: Cortland and Schoharie Counties.

North Carolina: Alleghany, Anson, Davidson, Halifax, Harnett, and Hertford Counties.

North Dakota: Bottineau County.

Ohio: Geauga, Hamilton, Lucas, and Miami Counties.

Oklahoma: Kay County.

Pennsylvania: Blair and Cambria Counties.

South Carolina: Berkeley and Richland Counties.

Texas: Bell, Eastland, and San Saba Counties.

Virginia: Alexandria and Fairfax Counties.

West Virginia: Gilmer and Lewis Counties.

Wisconsin: Portage and Wood Counties (detail); and south part of north-central reconnoissance area.

Work planned.—The areas approved by the Secretary for survey during the summer of 1916 are as follows:**SOIL SURVEY—DETAIL AREAS.**

Location.	Cooperation.	Probable date of completion.	Assignment.	Proposed expenditures, 1916-17.
Coosa County, Ala.....	Alabama Department of Agriculture and Industries and Alabama Experiment Station.	December, 1916.	H. C. Smith ¹	\$2,600
Fayette County, Ala.....	do.....	do.....	State men.....	None. ²
St. Clair County, Ala.....	do.....	January, 1917.....	R. T. A. Burke ¹	2,700
Faulkner County, Ark.....	do.....	December, 1916.....	E. B. Deeter.....	1,900
Santa Maria area, Cal.....	University of California and Agricultural Experiment Station.	November, 1916.....	E. B. Watson ¹	1,800
Jasper County, Ga.....	Georgia State College of Agriculture.	September, 1916.....	State men.....	None. ²
Benton County, Ind.....	Indiana Geological Survey.....	October, 1916.....	G. B. Jones ¹	1,800
Porter County, Ind.....	do.....	November, 1916.....	T. M. Bushnell ¹	1,700
Clay County, Iowa.....	Iowa State College of Agriculture and Experiment Station.	December, 1916.....	E. H. Smies ¹	1,600
Mitchell County, Iowa.....	do.....	do.....	W. E. Tharp ¹	1,800
Ringgold County, Iowa.....	do.....	do.....	E. C. Hall ¹	1,750
Shelby County, Ky.....	Agricultural Experiment Station.	November, 1916.....	C. Van Duyne ¹	1,750
Aroostook County, Me.....	Bureau of Plant Industry.....	do.....	L. A. Hurst, B. H. Hendrickson.....	2,200
Howard County, Md.....	Maryland Geological Survey.....	December, 1916.....	W. T. Carter, jr. ¹	1,600
Calhoun County, Mich.....	do.....	November, 1916.....	R. F. Rogers.....	1,450
Anoka County, Minn.....	Minnesota Agricultural Experiment Station.	December, 1916.....	W. G. Smith ¹	1,950
Newton County, Miss.....	Mississippi Geological Survey.....	do.....	A. L. Goodman ¹	1,670
Barry County, Mo.....	University of Missouri and Missouri Experiment Station.	do.....	A. T. Sweet ¹	2,200
Callaway County, Mo.....	do.....	do.....	Roy H. Hall ¹	1,850
Texas County, Mo.....	do.....	do.....	W. I. Watkins ¹	2,300
Box Butte County, Nebr.....	University of Nebraska.....	do.....	J. H. Agee ¹	2,250
Dodge County, Nebr.....	do.....	November, 1916.....	B. W. Tillman ¹	1,700
Fillmore County, Nebr.....	Agricultural Experiment Station.	September, 1916.....	A. H. Meyer ¹	750
Hall County, Nebr.....	do.....	October, 1916.....	J. O. Veatch.....	1,400
Belvidere area, N. J.....	New Jersey Experiment Station and New Jersey Geological Survey.	Summer, 1917.....	A. L. Patrick ¹	2,450
Millville area, N. J.....	do.....	do.....	J. M. Snyder ¹	2,250
Yates County, N. Y.....	New York State College of Agriculture.	November, 1916.....	E. T. Maxon ¹	1,950
Stanly County, N. C.....	North Carolina Department of Agriculture and North Carolina Experiment Station.	do.....	R. C. Journey ¹	1,450
Cleveland County, N. C.....	do.....	do.....	E. S. Vanatta ¹	1,650
Orange County, N. C.....	do.....	do.....	R. B. Hardison ¹	1,750

¹ Assisted by State representatives.² Expenses paid by State.

SOIL SURVEY—DETAIL AREAS—Continued.

Location.	Cooperation.	Probable date of completion.	Assignment.	Proposed expenditures, 1916-17.
Mahoning County, Ohio	Ohio Agricultural Experiment Station.	October, 1916....	M. W. Beck ¹	\$1,500
Marion County, Ohio....	.....do.....	.....do.....	T. M. Morrison ¹	1,500
Sandusky County, Ohio....	.....do.....	.....do.....	C. N. Mooney ¹	1,500
Payne County, Okla....	.....do.....	.....do.....	W. B. Cobb, H. W. Hawker.	2,650
Clearfield County, Pa..	Pennsylvania State College and Pennsylvania Experiment Station.	December, 1916..	R. A. Winston, R. W. McClure. ¹	3,300
Shelby County, Tenn..	Tennessee Geological Survey	July, 1916.....	H. H. Bennett ¹	1,050
Windsor County, Vt.....	.....do.....	September, 1916.	J. A. Kerr.....	1,200
Accomac County, Va.....	.....do.....	November, 1916.	E. H. Stevens.....	1,450
Pittsylvania County, Va.	Virginia Experiment Station	December, 1916..	N. M. Kirk ¹	3,250
Benton County, Wash.....	.....do.....	.....do.....	A. E. Kocher.....	2,450
Berkeley, Jefferson, and Morgan Counties, W. Va.	West Virginia Geological Survey.	.....do.....	W. J. Latimer.....	950
Door County, Wis.....	Wisconsin Geological and Natural History Survey.	November, 1916.	C. Thompson ¹	1,500
Rock County, Wis.....	.....do.....	.....do.....	A. E. Taylor ¹	1,800
Waupaca County, Wis.....	.....do.....	December, 1916..	C. Lounsbury ¹	1,800
Milwaukee, Wis.....	.....do.....	November, 1916.	State men.....	None. ²
				72,420

SOIL SURVEY—RECONNOISSANCE AREA.

Middle San Joaquin Valley, Cal.	University of California and Agricultural Experiment Station.	December, 1916..	L. C. Holmes, E. C. Eckmann. ¹	\$4,200
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DETAIL AREAS.

Winter and spring assignments, to be determined later.	\$54,020
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¹ Assisted by State representatives.² Expenses paid by State.

(**Reclamation Projects:** Project completed. Field examinations of the Montrose and Grand Junction, Colo., and the Minidoka, Idaho, reclamation projects have been completed and reports prepared and submitted to the Reclamation Service.)

Inspection of Field Work:

Object.—To inspect all work of the soil-survey field parties, examine and correct area reports, and prepare memoranda for soil correlation.

Location.—Headquarters, Washington, D. C.; much time is spent in the field in inspection work.

Date begun.—1898.

Results.—Inspection of all areas surveyed during the past year, including correction of reports and preparation of correlation memoranda.

Assignment.—H. H. Bennett, W. E. Hearn, M. H. Lapham, W. E. McLendon, T. D. Rice.

Proposed expenditures, 1916-17.—\$16,560.

Map Drafting:

Object.—Preparation of soil (both detail and reconnoissance), alkali, and land-classification maps; also page-plate illustrations; and securing map data in advance for field use.

Cooperation.—Other bureaus of the department and other departments.

Location.—Washington, D. C.

Date begun.—1898.

Map Drafting—Continued.

Results.—Have prepared and constructed base and soil maps, secured miscellaneous data for field and office use, adjusted traverse, plotted Land Office work and railroad and river surveys; compiled, redrawn, and colored from original field sheets and notes of the soil-survey parties maps to be used as copy in lithographic reproduction; verified names, measured the areas of the different soil types, prepared drawings for illustrating reports, written specifications for lithographic work, and read proof furnished through the Public Printer.

Assignment.—Charles A. Drake.

Proposed expenditures, 1916-17.—\$15,600.

Photographic Reproduction of Base Maps:

Object.—To enlarge or reproduce by photographic process base maps for use of soil-survey field parties and for the map-drafting force.

Location.—Washington, D. C.

Date begun.—1898.

Results.—Reproduced and mounted county maps of all areas surveyed during the year, developed negatives, and made prints used in bureau reports.

Assignment.—R. J. Bonde.

Proposed expenditures, 1916-17.—\$1,700.

Special Soil Studies:

Object.—To investigate the relation of soils to crops and prepare monographs on important soil series.

Location.—Washington, D. C., and in the field.

Date begun.—1911.

Results.—Studies made of the relation of soils to crops in central New Jersey, with especial reference to the Freehold, Hartford, Thoroughfare, and Dents areas, including preparation of reports; continued field studies of the Hagers-town soils between the Delaware and Roanoke Rivers.

Assignment.—J. A. Bonsteel.

Proposed expenditures, 1916-17.—\$5,050.

Advisory Service:

Object.—To answer inquiries regarding soils and give advice as to their use.

Cooperation.—Other bureaus of the department.

Location.—Washington, D. C.

Date begun.—1913.

Results.—It is estimated that replies have been made during the past year to upward of 1,200 inquiries regarding the use of soils.

Assignment.—J. E. Lapham.

Proposed expenditures, 1916-17.—\$2,500.

Supplies:

Object.—To purchase instruments and supplies required for use in the soil-survey work.

Location.—Washington, D. C.

Date begun.—1898.

Proposed expenditures, 1916-17.—\$3,000.

Total, Soil-Survey Investigations, \$194,200, including \$26,000 statutory.

[Research.]

CLASSIFICATION OF AGRICULTURAL LANDS IN FOREST RESERVES.**Forest-Land Classification:**

Object.—To classify and segregate agricultural lands in the national forests.

Cooperation.—Forest Service.

Location.—The several forest reserves.

Date begun.—1912.

Results.—During 1916: Fifteen projects examined and reports prepared and furnished the Forest Service in the following national forests:

Arizona: Sitgraves and Tusayan.

California: Angeles, Cleveland, Stanislaus, Sierra, and Sequoia.

Idaho: Boise.

Montana: Flathead, Jefferson, and Madison.

Wyoming: Teton.

Assignment.—A. C. Anderson, Mark Baldwin, C. E. Deardorff, J. E. Dunn, H. G. Lewis, W. A. Rockie, A. T. Strahorn.

Proposed expenditures, 1916-17.—\$18,100.

BUREAU OF ENTOMOLOGY.

GENERAL ADMINISTRATION.

Office of Chief:

Object.—General administration, supervision, and direction of the investigations and business activities of the bureau.

Cooperation.—All the bureaus of the department, other executive departments, and State institutions.

Location.—Washington, D. C.

Date begun.—1879.

Assignment.—L. O. Howard.

Proposed expenditures, 1916-17.—\$9,300.

Office of Chief Clerk:

Object.—The chief clerk is the executive officer of the bureau and has general supervision of the clerical force, the messenger and janitor service, the care of offices, and the maintenance of records.

Location.—Washington, D. C.

Date begun.—1879.

Assignment.—E. B. O'Leary.

Proposed expenditures, 1916-17.—\$8,930.

Accounts:

Object.—Supervision and maintenance of financial records of the bureau.

Location.—Washington, D. C.

Date begun.—1879.

Assignment.—A. J. Leister.

Proposed expenditures, 1916-17.—\$10,800.

Library:

Object.—To conduct work incidental to the maintenance of a library of entomological literature.

Location.—Washington, D. C.

Date begun.—1879.

Assignment.—Mabel Colcord.

Proposed expenditures, 1916-17.—\$3,360.

Supplies:

Object.—The purchase, custody, distribution, and record of all equipment and materials for field and office use.

Location.—Washington, D. C.

Date begun.—1879.

Assignment.—S. B. Walker.

Proposed expenditures, 1916-17.—\$4,540.

Editorial Work:

Object.—To conduct the editorial work of the bureau and facilitate the publication of the results of entomological investigations.

Location.—Washington, D. C.

Date begun.—1879.

Assignment.—R. P. Currie, B. A. Reynolds.

Proposed expenditures, 1916-17.—\$2,500.

Files and Records:

Object.—The filing of all correspondence pertaining to the operations of the bureau.

Location.—Washington, D. C.

Date begun.—1879.

Assignment.—T. A. Keleher.

Proposed expenditures, 1916-17.—\$1,400.

Total, General Administration, \$40,830, including \$36,230 statutory (research, \$37,400; regulation, \$3,430). This total includes \$1,600 from appropriation for miscellaneous insect investigations.

[Research.]

DECIDUOUS-FRUIT INSECT INVESTIGATIONS.

SUPERVISION.

Supervision:

Object.—To plan and direct the activities relating to deciduous-fruit insect investigations, including supervision of scientific work, general office routine, correspondence, etc.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—A. L. Quaintance.

Proposed expenditures, 1916-17.—\$7,700, including \$2,800 statutory.

APPLE INSECT INVESTIGATIONS.

Apple-Tree Borers:

Object.—To determine the life histories and habits of the various species of apple-tree borers and to develop appropriate remedies therefor.

Procedure.—Extensive investigations in orchards are made to determine species of troublesome borers and the amount of injury resulting from their work. Insects are collected and reared in the field laboratory and observations made on their life history, habits, etc. Laboratory observations are checked by extended observations in the field. Remedial measures are undertaken based on knowledge of the behavior of the insect. The work will be extended to include all important species of borers, with a view to furnish a comprehensive account of these insects as a class.

Location.—French Creek, W. Va.

Date begun.—1911.

Results.—The biologies of several species of borers have been investigated and other species are under investigation. Many preparations have been and are being tested as remedies, some of which are effective in preventing infestation by certain species.

During 1916 particular progress was made in the investigation of the round-headed apple-tree borer, and Farmers' Bulletin 675 giving results of the work was published.

Probable date of completion.—1920.

Assignment.—F. E. Brooks.

Proposed expenditures, 1916-17.—\$2,651.

Apple Plant Lice:

Object.—To determine the life histories of and remedies for apple aphids, such as the woolly apple aphid, green apple aphid, rosy apple aphid, etc.

Procedure.—Careful biological studies of these insects are made in the laboratory, especially to determine the character of injury, number of generations, host plants, manner of wintering, etc. Remedial investigations are undertaken in the field to determine the most effective sprays and times when applications should be made, as, in winter, for the destruction of eggs, and, in early spring, for the destruction of the newly hatched insects, and to determine the possibilities of control by the use of aphiscides in combination with other sprays. Future work on this project will include a study of other species of orchard aphids.

Location.—Washington, D. C., and Winchester, Va.

Date begun.—1912.

Results.—The biology of the woolly apple aphid has been thoroughly worked out and a publication already issued (Report No. 101, Office of the Secretary). Studies of the life history of the green apple aphid have also been finished and the results published in the Journal of Agricultural Research, vol. 5, No. 21. Experiments in orchards with sprays indicate effective control, under most conditions, by the timely use of these, especially nicotine sprays.

During 1916 special attention was given to an investigation of the rosy apple aphid, and a manuscript is now practically ready for publication.

Probable date of completion.—1920.

Assignment.—A. C. Baker, B. R. Leach.

Proposed expenditures, 1916-17.—\$5,260.

Codling Moth:

Object.—To determine what variations are necessary in spraying schedules to control the codling moth in widely separated fruit districts, such as Maine, Arkansas, Michigan, New Mexico, California, Colorado, the Allegheny region, etc.

Procedure.—Field laboratories are established in important apple-growing regions representing essentially different climatic and other conditions. The biology of the codling moth is thoroughly investigated, especially as bearing on the question of its control in orchards. Experiments are carried out in the field to determine the comparative value of the respective spray treatments, the most effective quantity of poison to be employed, and similar questions of practical importance. The work will be extended to one or two additional apple-growing sections in the United States, which will complete the project.

Cooperation.—Colorado Experiment Station.

Location.—Grand Junction, Colo., and Roswell, N. Mex.

Date begun.—1908.

Results.—Work has been completed in Michigan, Pennsylvania, the Allegheny region, Arkansas, and California, and reports have been issued for these regions. Department Bulletin 252, "Life History of the Codling Moth in Maine," has also been issued.

During 1916 special progress was made in a study of the biology of the codling moth under arid conditions in the Grand Valley of Colorado. In New Mexico large-scale experiments were carried out in orchards in the use of dust sprays, with encouraging results.

Probable date of completion.—1920.

Assignment.—E. H. Siegler, H. K. Plank, R. J. Fiske.

Proposed expenditures, 1916-17.—\$6,750.

Relation of Insects to Stigmonose:

Object.—To determine the relation of insects, especially hemipterous insects, to the affection of apples known as stigmonose.

Procedure.—Thorough search is made in orchards for insects likely to be associated with stigmonose trouble. These insects are brought to the laboratory and studied under exact conditions. Numerous species of hemiptera, especially plant lice, are under observation, and the inquiry will be extended to all species which, from their habits, are likely to be concerned.

Cooperation.—Bureau of Plant Industry.

Location.—Wenatchee, Wash.

Date begun.—1914.

Results.—The experiments thus far made to determine the relation of insects to stigmonose have not been conclusive in establishing the connection of any one insect species with the trouble, though plant lice may be connected with it. Thus during 1916 spraying experiments for the control of plant lice in orchards showed a reduction in the amount of stigmonose, and further tests are under way to determine the degree of benefit to be expected in preventing stigmonose trouble from aphid control.

Probable date of completion.—1918.

Assignment.—E. J. Newcomer.

Proposed expenditures, 1916-17.—\$2,465.

Total, Apple Insect Investigations, \$17,126, including \$720 statutory.

PEACH INSECT INVESTIGATIONS.**Peach Borer and Miscellaneous Peach Insects:**

Object.—To determine the life history and habits of the peach-tree borer and other peach insects and to develop appropriate remedies therefor.

Procedure.—The biology of the peach borer is investigated in orchards and in the laboratory, and experiments with remedies are conducted on a large scale in orchards. In connection with this work other peach insects, such as the plum curculio, peach-twig borer, etc., are studied and experiments in their control made. The work eventually is to cover all of the more important peach insects in the United States.

Location.—Springfield, W. Va.

Date begun.—1911.

Results.—The biology, food plants, etc., of the peach borer have been pretty well determined for different parts of the country where peaches are grown. Numerous washes and practices recommended for its control have been tried, many of which have been found to be without value.

Peach Borer and Miscellaneous Peach Insects—Continued.

During 1916 special attention was given to experiments with soil fumigants to determine the required dosage to kill the insects and the effect of these dosages on the trees treated. The results thus far obtained indicate the practicability of the use of poisonous gases in the control of the peach borer.

Assignment.—E. B. Blakeslee.

Proposed expenditures, 1916-17.—\$2,700.

GRAPE INSECT INVESTIGATIONS.**Grape Phylloxera and Miscellaneous Grape Insects in California:**

Object.—To determine the life history of the grape Phylloxera under California conditions, means of dispersal, comparative resistance of different varieties of grapes to Phylloxera, and possibilities of the renovation of old infested vineyards, and to investigate miscellaneous grape insects of importance in California.

Procedure.—The biology of the grape Phylloxera is carefully studied, especially as bearing on the question of its control in vineyards. Extensive experiments are under way in vineyards to determine the best remedial measures to be employed. The possibility of renovating old infested vineyards is also under investigation. The biology of the grapevine mealy bug is being investigated in the laboratory, and control work is under way in vineyards. Preliminary studies of the grape leafhopper and red spider under California conditions have been begun and will be extended.

Cooperation.—Bureau of Plant Industry (varietal resistance).

Location.—Walnut Creek, Cal.

Date begun.—1912.

Results.—Studies of the biology of the grape Phylloxera are completed and a manuscript and illustrations prepared for publication.

During 1916, in cooperation with the Bureau of Soils, special attention was given to an investigation of the relation of vineyard soils to Phylloxera injury and valuable data were accumulated. Extensive experiments were also made in the use of carbon bisulphide injected into the soil for the destruction of the Phylloxera on the roots of the grapevine. The hard condition of the soil in many localities renders work of this character much less practicable than in many parts of southern Europe.

Probable date of completion.—1920.

Assignment.—R. L. Nougaret.

Proposed expenditures, 1916-17.—\$2,700.

Grape Berry Moth and Miscellaneous Grape Insects in the East:

Object.—To determine the life history and habits of the grape berry moth and other important insects affecting the grape and to develop remedies for their control.

Procedure.—The biology of the grape berry moth is carefully studied as a basis for the control of this insect in vineyards. Extensive spraying and other experiments are carried on in vineyards to determine the best remedial measures to be employed. In connection with this work other important grape insects are being investigated.

Location.—North East, Pa., and Sandusky, Ohio.

Date begun.—1907.

Results.—Many data on the biology of the grape berry moth have been obtained and a publication issued (Entomology Bulletin 116, Part 2, new series). The life histories of several important grape pests have been determined, effective remedies developed, and publications issued, including the grape root worm (Entomology Bulletin 89, new series), grape leafhopper (Department Bulletin 19), and the rose chafer (Farmers' Bulletin 721).

During 1916 experiments with sprays against the grape berry moth in vineyards at North East, Pa., encourage the belief that this pest may be largely controlled by one or two thorough sprayings against the first brood of larvæ.

Cooperation.—Ohio Agricultural Experiment Station.

Probable date of completion.—1920.

Assignment.—Dwight Isely, H. G. Ingerson.

Proposed expenditures, 1916-17.—\$5,880.

Total, Grape Insect Investigations, \$8,580.

NUT INSECT INVESTIGATIONS.

Pecan Insects:

Object.—To determine the biologies of and remedies for the principal pecan insects.

Procedure.—Careful biological studies are made of the more important pecan insects, and experimental control work in pecan groves is carried out.

Location.—Monticello, Fla.

Date begun.—1913.

Results.—A large amount of data on important pecan insects has been accumulated. It is hoped that a manuscript may be shortly prepared for publication on the more important insect enemies of this crop.

During 1916 special attention was given to an investigation of the practicality of controlling the pecan case bearer and bud moth by the use of arsenical sprays, with very promising results.

Probable date of completion.—1918.

Assignment.—J. B. Gill, A. I. Fabis.

Proposed expenditures, 1916-17.—\$4,666.

Chestnut Weevils and Miscellaneous Nut Insects:

Object.—To determine the biologies of and remedies for chestnut weevils and other important nut insects.

Procedure.—Careful biological studies will be made of chestnut weevils and other important nut insects, and experimental work in chestnut groves will be carried out.

Location.—To be determined later.

Date begun.—July 1, 1916.

Probable date of completion.—1920.

Assignment.—Leader to be assigned later.

Proposed expenditures, 1916-17.—\$2,031.

Total, Nut Insect Investigations, \$6,697.

INVESTIGATIONS OF ORCHARD INSECTICIDES AND SPRAYING MACHINERY.

Orchard and Miscellaneous Insecticides:

Object.—To determine the comparative value of insecticides in general use and to what extent they may be combined with fungicides of various kinds in the control of insect plant pests; to develop new insecticides and determine their value in insect control and their effect on the insects and plants treated.

Procedure.—Numerous insecticides are tested under laboratory and field conditions against different species of insects, alone and in combination with fungicides. Experimental work is carried on in combining chemicals to form new insecticides. Before recommendations can be made such insecticides must be fully tested, in order to determine their efficiency against insects and their action on plant life when used alone and when in combination with fungicides.

Cooperation.—Bureaus of Plant Industry and Chemistry.

Location.—Benton Harbor, Mich., and Washington, D. C.

Date begun.—1912.

Results.—Orchard tests have been made with many types of commercial insecticides to determine their relative merits. New commercial insecticides are tested as far as practicable, as they appear from year to year, for the information of the department. Feeding experiments have been made with many toxic substances, to determine their usefulness as insecticides.

During 1916 a publication on miscellaneous insecticide investigations (Department Bulletin 278) was issued. In addition to other data reported, the results of experiments with arsenate of lime were given, the publication of these facts being largely responsible for the adoption of this arsenical in spraying operations by orchardists and others in view of its cheapness as compared with other arsenicals.

Assignment.—A. L. Quaintance, F. L. Simanton, W. B. Wood.

Proposed expenditures, 1916-17.—\$4,392.

Insecticidal Constituents of Plants:

Object.—To make a thorough study of known and possible plant constituents having insecticidal value and to determine the physiological action of these substances on insects; to test insecticides thus obtained under field conditions, and to introduce into use such insecticides where feasible.

Procedure.—Studies under this project will involve work on pharmaceutical botany and pharmaceutical chemistry and the exact determination of the physiological action of the substances obtained on different classes of insects.

Insecticidal Constituents of Plants—Continued.

Cooperation.—Office of Drug and Poisonous Plant Investigations, Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1916.

Results.—Too early to report results under this project.

Assignment.—N. E. McIndoo.

Proposed expenditures, 1916-17.—\$2,550.

Spraying Apparatus and Spraying Efficiency:

Object.—To investigate the relative efficiency of spraying apparatus, noting especially principles of construction, types of gasoline motors, pumps, etc.

Procedure.—The relative efficiency of the many types of spraying apparatus now on the market will be investigated in orchards and factories. Attention will be given to determine the durability of materials used in pumps as affected by spray liquids, methods of packing valves, and other practical points. An estimate will also be made of spraying efficiency as practiced by various orchardists, vineyardists, etc., as a basis for suggestions for improvements in such work.

Cooperation.—Bureau of Plant Industry and Office of Public Roads and Rural Engineering.

Location.—Washington, D. C.

Date begun.—1914.

Results.—Data have been accumulated on the comparative merits of different types of spray nozzles and spraying accessories, as well as on the comparative value in codling-moth control of sprays applied under low and high pressure.

Assignment.—A. L. Quaintance.

Proposed expenditures, 1916-17.—\$500.

Total, Investigations of Orchard Insecticides and Spraying Machinery,
\$7,442.

CRANBERRY AND SMALL-FRUIT INSECT INVESTIGATIONS.**Cranberry and Small-Fruit Insect Investigations:**

Object.—To study insects affecting the cranberry and other small fruits, such as the currant, gooseberry, huckleberry, blueberry, etc., and to develop effective control measures.

Procedure.—Work at present is confined largely to the cranberry. Careful biological studies are made of the injurious insects of this crop, special attention being paid to their seasonal history in bogs, places of hibernation, etc. Experiments with insecticides are in progress to determine the best remedial measures, and observations on such practices as sanding bogs and reflooding after the bogs have been drained in the spring are also being made.

Location.—Brown Mills, N. J.

Date begun.—1913.

Results.—A large amount of data has been accumulated on important cranberry insects in New Jersey and on the effectiveness of flooding bogs, and spraying operations in the control of the pests have been investigated. Improvement has been effected in insecticidal sprays used. A heretofore unrecognized cranberry insect has been discovered and reported upon in Department Bulletin 263.

During 1916 special attention was given to obtaining additional information about cranberry fireworms and the cranberry girdler. Experiments made in the control of fireworms developed a successful treatment for these insects.

Probable date of completion.—1918.

Assignment.—H. B. Scammell.

Proposed expenditures, 1916-17.—\$2,200.

CONTROL OF DECIDUOUS-FRUIT INSECTS BY NATURAL AGENCIES.**Parasitic Hymenoptera:**

Object.—To determine the importance of hymenopterous parasites in the control of deciduous-fruit insect pests and devise methods for their practical propagation and dissemination.

Procedure.—Parasitized insects are collected from various localities and sent to the laboratory at North East, Pa., for the rearing of parasites. Life histories and habits of parasites are worked out and efforts made to effect their propagation in quantity for dissemination.

Location.—North East, Pa.

Date begun.—1911.

Parasitic Hymenoptera—Continued.

Results.—Biological data have been obtained on several important parasites of deciduous-fruit insects as a basis for their intelligent propagation. Many new parasites have been discovered and their economic status determined. Special attention has been given to parasites of the grape berry moth, and numerous species are being studied in detail. Results of investigations of the *Calliephialtes* parasite of the codling moth have been reported in the *Journal of Agricultural Research*, vol. 1, No. 3.

During 1916 studies were completed on the *Thersilochus* parasite of the plum curculio and a manuscript prepared for publication.

Assignment.—R. A. Cushman.

Proposed expenditures, 1916-17.—\$2,250.

Predatory Insects:

Object.—To determine the importance of predatory insects in the control of deciduous-fruit insect pests and to carry out large-scale experiments in their practical propagation and dissemination.

Procedure.—Predatory insects, especially lady-bird beetles, Syrphid flies, tiger beetles, etc., will be collected and their life histories and habits studied. Where feasible, large quantities of valuable predators will be collected in the field and distributed to other parts of the country. In the laboratory valuable species will be propagated in quantity for dissemination.

Location.—Walnut Creek, Cal.

Date begun.—1916.

Results.—Work has not been in progress sufficiently long to warrant a statement of results.

Probable date of completion.—1920.

Assignment.—W. M. Davidson.

Proposed expenditures, 1916-17.—\$2,100.

Fungous Diseases of Insects:

Object.—To investigate the fungi parasitic on deciduous-fruit insects, with a view to their utilization in the control of insect pests.

Procedure.—Mycological methods of study will be employed in the isolation and growing of the organisms. Pure cultures of various species of fungi will be experimented with to determine their period of incubation, method or methods of attacking insects, and the possibility of increasing their virulence. Attention will be given to the development of methods whereby fungi can be grown in large quantities, with a view to effecting control of injurious insects in the field.

Cooperation.—Bureau of Plant Industry.

Location.—Washington, D. C.

Date begun.—1916.

Results.—Work has not been in progress sufficiently long to warrant a statement of results.

Assignment.—A. T. Speare.

Proposed expenditures, 1916-17.—\$2,550.

Total, Control of Deciduous-Fruit Insects by Natural Agencies, \$6,900.

DECIDUOUS-FRUIT NURSERY INSECT INVESTIGATIONS.**Deciduous-Fruit Nursery Insect Investigations:**

Object.—To investigate the various insects affecting nursery stock and to develop remedies which may be effectively applied under nursery conditions; to investigate the efficiency of fumigation methods now employed by nurserymen, and to effect improvement in disinfecting nursery stock.

Procedure.—Careful studies are made of all important insect enemies of nursery stock and remedies developed which may be applied under nursery conditions. Observations are made on methods of fumigation now practiced by nurserymen, the efficiency of this work, and effect on the plants treated.

Location.—West Chester, Pa.

Date begun.—1914.

Results.—Valuable information has been accumulated on different species of insects which are the most important pests of nursery trees, and the life histories and habits of some of these have been studied. Experiments have been made in the fumigation of nursery stock, and inquiry is under way on fumigation methods practiced by nurserymen and on their fumigatoriums, with the view of ascertaining how effectively the work is being done and of suggesting improvements in methods where necessary.

Deciduous-Fruit Nursery Insect Investigations—Continued.

During 1916 special attention was given to experiments in the control of the woolly apple aphid, and numerous substances were tested to determine their usefulness in destroying this insect around the roots of the growing nursery stock. Special attention was also given to the apple leafhopper, including a study of its biology, and large-scale spraying experiments were made in its control under nursery conditions.

Assignment.—A. J. Ackerman.

Proposed expenditures, 1916-17.—\$2,096.

ORCHARD INSECT SURVEY.**Orchard Insect Survey:**

Object.—To obtain information on the large number of insect pests of orchards, vineyards, etc., at present of lesser importance in the United States, but which may become important at any time.

Procedure.—Insect outbreaks of a serious nature are investigated and information obtained on conditions responsible for such outbreaks. Insects are collected in orchards, vineyards, etc., and a good many are obtained through correspondence. Necessary records, photographs, and drawings of insects and of plant specimens showing injury are made, to be used in publications and for reference purposes.

Location.—Washington, D. C.

Date begun.—Work of this character has been in progress for many years.

Results.—A large amount of information has been accumulated on miscellaneous insects of the orchard, vineyard, etc., in the United States. Specimens of these have been collected for use in making drawings and descriptions. A large collection of notes and photographs is already on file and is being rapidly enlarged.

Assignment.—J. H. Paine, J. F. Strauss.

Proposed expenditures, 1916-17.—\$2,859.

Total, Deciduous-Fruit Insect Investigations, \$64,300, including \$3,520 statutory.

[Research.]

CEREAL AND FORAGE INSECT INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To plan and direct the activities relating to cereal and forage insect investigations, including supervision of scientific work, general office routine, correspondence, etc.

Location.—Washington, D. C.

Date begun.—1904.

Assignment.—W. R. Walton.

Proposed expenditures, 1916-17.—\$6,720, including \$2,720 statutory.

CEREAL INSECT INVESTIGATIONS.**Hessian Fly:**

Object.—To study the life history, development, and distribution of the parasites of the Hessian fly, in order that their services may be artificially utilized more intelligently; to determine the cause of the nonoccurrence of the Hessian fly under agricultural conditions that would seem to favor its development; to determine varieties of grain least subject to attack.

Procedure.—The work consists chiefly of field experiments, small plots of wheat being sown every ten days in the fall, extending over a period of two or three months, in all States where this pest is destructively abundant.

Location.—Eastern United States and middle United States.

Date begun.—1905.

Results.—Three publications dealing with this pest have been issued during the past year, showing graphically the life history and the approximate time for planting fly-free wheat in the principal winter-wheat growing regions of the United States during years when normal meteorological conditions prevail. These preliminary publications require amplification and some correction but will serve as a basis for further investigations. Excellent progress has been made in the investigation of the natural enemies of the Hessian fly, especially its insect enemies. The number of species of these parasites has been found to be very much larger than was hitherto supposed. An immense amount of valuable biological information has been secured but is not yet ready for publication.

Probable date of completion.—1920.

Hessian Fly—Continued.

Assignment.—E. O. G. Kelly, W. R. McConnell, C. N. Ainslie, J. J. Davis, T. D. Urbahns.

Proposed expenditures, 1916-17.—\$7,560.

Dipterous Enemies of Grains Other than the Hessian Fly:

Object.—To determine accurately other species of flies attacking wheat and other grains whose ravages are wrongly charged to the Hessian fly and to devise preventive measures directed more definitely against such pests.

Procedure.—This project is conducted in essentially the same manner as are the Hessian-fly investigations.

Location.—Various points throughout the grain-growing sections of the United States.

Date begun.—1884.

Results.—Progress has been made in the positive identification of some of the species involved. Careful biological studies have been conducted for this purpose.

Probable date of completion.—1918.

Assignment.—J. M. Aldrich, E. O. G. Kelly, C. N. Ainslie, W. R. McConnell.

Proposed expenditures, 1916-17.—\$4,500.

Cutworms:

Object.—To investigate the life history and habits of all species of cutworms in the United States affecting corn and grass, together with their parasites and other natural enemies.

Procedure.—The diverse habits of the various species of cutworms make it necessary that each species be studied separately over its entire area of distribution, and this is accomplished by means of extensive field studies and laboratory investigations.

Location.—Temporary and other field stations throughout the United States.

Date begun.—1912.

Results.—Farmers' Bulletin 739 has been issued, giving the methods of controlling cutworms in general. The identity of the "over-flow" worm of the Mississippi Valley has been definitely determined, and measures of control are being worked out. Progress has also been made in the investigations of the western army cutworm. These investigations are being continued and will be pushed vigorously during the ensuing year.

Assignment.—W. R. Walton, J. J. Davis, C. N. Ainslie, W. H. Larrimer.

Proposed expenditures, 1916-17.—\$3,500.

Corn-Leaf Aphis:

Object.—To determine the relation of the corn-leaf aphis (*Aphis maidis*) to other similar species; to investigate methods of control, especially along the southern border of the country, where, instead of attacking corn, as in the North, it attacks and destroys young growing barley, in some localities preventing the cultivation of that crop; it is also a serious pest on sorghum in the Gulf States.

Procedure.—This project is conducted by means of laboratory experiments, field work in small laboratory plats, and field experimentation on selected farms.

Location.—Brownsville, Tex., Knoxville, Tenn., and Tempe, Ariz.

Date begun.—1911.

Results.—Important biological studies of this species have been almost completed, showing that colonies in the North are almost certainly established by migrants from the South and that there are no true sexual forms present in the Gulf region, the females reproducing viviparously during the year. Studies of the parasitic or predaceous enemies of this important pest are also being conducted.

Probable date of completion.—1917.

Assignment.—R. A. Vickery, G. G. Ainslie, V. L. Wildermuth.

Proposed expenditures, 1916-17.—\$3,000.

(Fungous Enemies of the Chinch Bug: This project has been abandoned for the reason that it has been definitely determined that the fungous diseases affecting the chinch bug are of comparatively little value in the control of this important pest.)

Chinch Bug:

Object.—To investigate all possible means of controlling this insect, including the efficiency of burning grass during winter and early spring and other mechanical methods of destroying hibernating chinch bugs and of preventing the migration of these insects from one field to another.

Chinch Bug—Continued.

Procedure.—Careful experiments are conducted to determine the best methods of handling the margins of fields where these pests hibernate, with burning and other experiments designed to destroy them while in hibernation or migration.

Location.—Wellington, Kans., Lafayette, Ind., and Charleston, Mo.

Date begun.—1911.

Results.—It has been determined that the burning of bunches of a widely distributed wild grass in the fall is effective as a control measure, where practicable, and that spring burning of the same is much less effective. Experiments were also carried on with the view of improving the old ditch and drag and tar-line methods of control. This phase of the investigation will be continued.

Probable date of completion.—1917.

Assignment.—E. O. G. Kelly, J. J. Davis, W. H. Larrimer.

Proposed expenditures, 1916-17.—\$4,500.

Western Corn Rootworm:

Object.—To find some practical means of preventing injuries by the corn rootworm in sections subject to the annual overflow of streams.

Procedure.—Both laboratory and field experiments are conducted, the latter being in many instances in cooperation with farmers.

Location.—Nashville, Tenn., Lafayette, Ind., and Elk Point, S. Dak.

Date begun.—1912.

Results.—This project must necessarily be continued because of the fact that unfavorable weather conditions during the past year have interfered with the investigations. Preliminary results were published in Department Bulletin 8.

Probable date of completion.—1918.

Assignment.—G. G. Ainslie, J. J. Ainslee, J. J. Davis, W. H. Larrimer.

Proposed expenditures, 1916-17.—\$2,250.

Southern Corn Rootworm:

Object.—To devise means for protecting the corn crop in the Southern States from the ravages of the rootworm.

Procedure.—A careful study of the life history of this species is being made by laboratory experimentation, and field experiments are being carried out on a small scale.

Cooperation.—University of South Carolina and University of Florida.

Location.—Knoxville, Tenn., Charleston, Mo., Gainesville, Fla., and Columbia, S. C.

Date begun.—1913.

Results.—Satisfactory progress has been made on the preliminary work and a comprehensive study of this species made in the South Atlantic States, but it is yet too soon to report definite results. Preliminary data are contained in Department Bulletin 5.

Probable date of completion.—1918.

Assignment.—W. H. Larrimer, G. G. Ainslie, R. N. Wilson, Philip Luginbill.

Proposed expenditures, 1916-17.—\$4,000.

Colorado Corn Rootworm:

Object.—To study the life history and natural diffusion of the species and the conditions under which it may attack growing corn; to ascertain the difference in the work of this insect and that of closely allied species; and to find out whether the same methods of suppression are applicable to its control.

Procedure.—The methods by which this investigation is carried on are substantially the same as those which are in use in the investigations of the western and southern corn rootworms.

Location.—Maxwell, N. Mex., and Charleston, Mo.

Date begun.—1913.

Results.—On account of unfavorable weather conditions this project has been retarded and further work will be necessary.

Probable date of completion.—1918.

Assignment.—D. J. Caffrey.

Proposed expenditures, 1916-17.—\$750.

Wireworms:

Object.—To determine the different species of wireworms attacking grain and forage crops, their habits and life histories, the most favorable conditions for their development, and methods of control.

Wireworms—Continued.

Procedure.—Each species is carefully studied under laboratory conditions and these results checked by field experiments conducted under conditions like those experienced by the farmer in combating the pest.

Location.—Hagerstown, Md., Charleston, Mo., Gainesville, Fla., and West Springfield, Mass.

Date begun.—1911.

Results.—This project has been pushed vigorously during the past year. Thousands of wireworms have been reared under laboratory conditions, in order to definitely determine the identity of the truly economic species. Important field experiments are being conducted with a view to ascertain the effects of tile drainage on certain species of wireworms inhabiting low-lying wet land, such as river bottoms. Farmers' Bulletin 725 has been published, giving general methods of control for those species which have been found amenable to control by cultural methods. A farmers' bulletin has also been prepared dealing with the corn and cotton wireworm, a species infesting light sandy soils, especially in the central and eastern portions of the country.

Probable date of completion.—1918.

Assignment.—J. A. Hyslop, W. H. Larrimer, R. N. Wilson, Harrison E. Smith.

Proposed expenditures, 1916-17.—\$5,100.

Diabrotica Balteata:

Object.—To determine the extent to which this pest is liable to become diffused northward from Texas and to devise measures for restricting or eliminating its ravages.

Procedure.—Close observations are made in cage experiments in the laboratory and in small out-of-door experiments. The results thus obtained are then applied on a larger scale in field plats.

Location.—Brownsville, Tex.

Date begun.—1912.

Results.—Studies of the life history, seasonal history, and manner of injury by this beetle have been conducted. No satisfactory control measures have as yet been discovered, and further investigation will be necessary.

Probable date of completion.—1918.

Assignment.—R. A. Vickery.

Proposed expenditures, 1916-17.—\$500.

Native Species of White Grub:

Object.—To destroy or prevent the appearance of white-grub (*Lachnosterna*) larvæ in fields, determine the identity of parasites and the extent to which such natural enemies may be artificially utilized, study the life cycle of the various species, and discover whether or not this pest can be successfully combated by definite systems of crop rotation designed to hold it in check.

Procedure.—The leader of this project visits various sections of the country where the larvæ or grubs occur in destructive abundance, studying the nature of the soil, the topography of the country, and the nature of the forest flora which is most likely to produce food for the adult beetle. Collections are made at the time of plowing the infested fields, and this information is studied with relation to previous systems of crop rotation.

Cooperation.—State entomologists of Illinois, Alabama, and Texas and the government entomologists of the Dominion of Canada.

Location.—La Fayette, Ind., Charlottesville, Va., Hagerstown, Md., and Wellington, Kans.

Date begun.—1911.

Results.—Material progress has been made on this important investigation. A summary of methods of control has been published in the Weekly News Letter of the department, and a publication dealing with the natural enemies of white grubs is in course of preparation.

Probable date of completion.—1919.

Assignment.—J. J. Davis, W. J. Phillips, J. A. Hyslop, H. E. Smith.

Proposed expenditures, 1916-17.—\$12,000.

Jointworms:

Object.—To establish the identity of each of the grain or grass infesting species and their relationship to one another, determine the area of distribution of the at present supposed species, and investigate methods of control, including studies of natural enemies.

Procedure.—The various species are artificially reared in laboratory experiments from their native wild grasses, and field tests are then made to see whether the pest will forsake its natural food plant to attack cultivated grains and grasses.

Jointworms—Continued.

Location.—Charlottesville, Va., Elk Point, S. Dak., and Charleston, Mo.

Date begun.—1911.

Results.—The life histories of most of the species known to occur east of the Mississippi River have been worked out. Field experiments looking to the control of these pests have been conducted, but further studies will be necessary before definite results can be obtained.

Probable date of completion.—1918.

Assignment.—W. J. Phillips, C. N. Ainslie.

Proposed expenditures, 1916-17.—\$3,600.

Sod Webworms:

Object.—To study the life history, habits, and natural enemies of these moths and their larvæ in connection with the cultivation of cereals throughout the United States.

Procedure.—The life history and habits of this species are being minutely studied by means of cage experiments in the laboratory and out of doors. These are supplemented by experiments conducted under field conditions.

Location.—Nashville, Tenn., Charlottesville, Va., Hagerstown, Md., and West Springfield, Mass.

Date begun.—1913.

Results.—Much information has been obtained in relation to these insects. A series of papers dealing with the life histories of various species is in course of preparation. Methods of control for one of the more commonly injurious species have been secured and a publication is being prepared.

Probable date of completion.—1918.

Assignment.—G. G. Ainslie, W. J. Phillips, J. A. Hyslop, Harrison E. Smith.

Proposed expenditures, 1916-17.—\$4,000.

Fall Army Worm:

Object.—To investigate the life history, areas of perpetual habitation, and the natural enemies of this pest; to devise methods of control in the South, in order to prevent destructive invasions such as occurred in 1912.

Procedure.—This project is being conducted by means of extensive field observations and experiments, wherein this pest is carefully studied with special reference to its parasitic enemies.

Location.—Brownsville, Tex., Columbia, S. C., Gainesville, Fla., Greenwood, Miss., and Nashville, Tenn.

Date begun.—1912.

Results.—Investigations during the past year have shown that this pest did not survive the winter north of central Texas and northern Florida. A farmers' bulletin dealing with the control of this serious pest is in preparation, but the full results of these investigations can not be secured short of another year's work.

Probable date of completion.—1918.

Assignment.—R. A. Vickery, Philip Luginbill, R. N. Wilson, C. F. Turner, G. G. Ainslie, E. O. G. Kelly.

Proposed expenditures, 1916-17.—\$8,500.

False Wireworms:

Object.—To study the life history and habits of false wireworms affecting growing grain and to devise methods for their control.

Procedure.—Similar to that adopted in investigating wireworms.

Location.—Wellington, Kans., Maxwell, N. Mex., and Tempe, Ariz.

Date begun.—1911.

Results.—These investigations have uncovered very significant facts during the past year. It seems probable from present knowledge that much serious damage to cereals in the Great Plains region, hitherto attributed to unfavorable weather conditions, has been due to the insidious work of the underground larvæ of these beetles. Several insect parasites of the pest have been discovered, and their economic importance is being investigated.

Probable date of completion.—1918.

Assignment.—E. O. G. Kelly, D. J. Caffrey, V. L. Wildermuth.

Proposed expenditures, 1916-17.—\$1,000.

Miscellaneous Cereal Insects:

Object.—To investigate sporadic or periodic outbreaks of insects that may attack cereal crops in the field and any other cereal-infesting insects whose sudden appearance in unusual numbers may require immediate investigations; also to investigate such other cereal insects as may not heretofore have been known as destructive.

Date begun.—1910.

Results.—The life history of the lesser cornstalk borer has been ascertained, and a publication is being prepared giving measures of control.

An entirely new publication, Farmers' Bulletin 731, has been issued, giving methods of control and fully illustrating the various stages of the army worm, together with its natural enemies.

A beetle (*Ligyrrus rugiceps*) seriously injuring corn in the South Atlantic and Gulf States has been investigated. Its life history has been ascertained, and measures of control are being worked out.

A leaf miner (*Cerodonta dorsalis*) affecting small grains has been studied, its natural history ascertained, and a bulletin dealing with its economic phases prepared for publication.

Several publications have been issued on the green bug, warning farmers of an impending outbreak of this important pest, which outbreak developed during the past spring in the States of Oklahoma, Texas, and Kansas. Investigations of the pest have been continued both in the Great Plains region and in the South Atlantic States. A publication relating to the life history of the green bug in the latter region is in course of preparation.

An outbreak of a pest attacking small grains (*Pentatoma sayii*) occurred in New Mexico during the past summer and was carefully investigated. The life history of the insect was ascertained and several useful insect parasites of the species discovered.

Assignment.—All members of the staff.

Proposed expenditures, 1916-17.—\$3,500.

Total, Cereal Insect Investigations, \$68,260, including \$3,000 statutory.

FORAGE INSECT INVESTIGATIONS.**Alfalfa-Seed Chalcis:**

Object.—To study the life history of the insect and determine some practical method of preventing the large percentage of loss of clover and alfalfa seed due to chalcis; to conduct life-history studies of native parasites of the alfalfa and clover seed chalcis, with the view of controlling the pest.

Procedure.—Laboratory investigations of the insect and its parasites, checked by field observations, are conducted.

Location.—Pasadena, Cal., Tempe, Ariz., and Forest Grove, Oreg.

Date begun.—1912.

Results.—Studies of several of the insect parasites of this pest have been completed, and the results are in course of preparation for publication. Other enemies are being investigated, and the project is being continued with a view to discover additional methods of control. A preliminary paper relative to cultural methods for controlling this insect has been published as Farmers' Bulletin 636.

Probable date of completion.—1918.

Assignment.—T. D. Urbahns, V. L. Wildermuth, C. W. Creel.

Proposed expenditures, 1916-17.—\$14,200.

Insects Affecting the Production of Clover Seed:

Object.—To carry on life-history studies of the clover-seed chalcis, which affects both clover and alfalfa, and investigate various other insects affecting clover seed, including a study of insect fertilization of the bloom.

Procedure.—Mode of procedure similar to that followed in investigating the alfalfa-seed chalcis.

Location.—Forest Grove, Oreg., Hagerstown, Md., and West Springfield, Mass.

Date begun.—1911.

Results.—A comprehensive study of the clover-flower midge has been inaugurated in the Pacific Northwest. A thorough study of the biology and behavior of this important pest is being carried on, in order to secure reliable methods of control adapted to the conditions peculiar to that portion of the country. Progress has also been made on the investigation of the clover-seed chalcis.

Probable date of completion.—1918.

Assignment.—C. W. Creel, J. A. Hyslop, H. E. Smith.

Proposed expenditures, 1916-17.—\$6,000.

Insects Affecting Soy Beans:

Object.—To study the life history and habits of insects affecting this crop, which is constantly increasing in importance.

Procedure.—This project is conducted by means of laboratory and out-of-door breeding experiments, the results of such experiments being then checked up by careful field application.

Location.—Charlottesville, Va., Columbia, S. C., Greenwood, Miss., and Charleston, Mo.

Date begun.—1912.

Results.—Considerable progress has been made on these investigations. The life histories of *Cleora pampinaria* and *Platynota flavedana* have been nearly completed, and methods for the control of these pests are being worked out and will soon be ready for publication. Several other important pests are under investigation.

Probable date of completion.—1919.

Assignment.—Philip Luginbill, C. N. Ainslie, C. F. Turner, W. R. McConnell, W. H. Larrimer.

Proposed expenditures, 1916-17.—\$3,100.

Range Caterpillar:

Object.—To determine methods of eradicating the insect during its different stages of development, and to experiment with parasites and other predacious insects and with mechanical devices for the control of this pest.

Procedure.—Life-history studies of the insect have been made by means of cage experiments and field observations. Observations and experiments with native and imported parasites of this pest are being carried on in cages and in the field, and various mechanical devices are being tested.

Location.—Maxwell, N. Mex.

Date begun.—1913.

Results.—A great number of the natural insect enemies of this pest have been transported and introduced into that portion of New Mexico infested by this caterpillar. At least two species of these enemies have apparently become established, but it is too soon to expect any positive results from this work. This pest showed a tendency to change its food habits during the past year, necessitating additional investigations of the insect.

Probable date of completion.—1917.

Assignment.—D. J. Caffrey.

Proposed expenditures, 1916-17.—\$4,000.

Alfalfa Weevil:

Object.—To colonize and study the life history and habits of insect and fungous enemies of the alfalfa weevil; to determine the efficiency of cultivation and irrigation, either combined or independently, as a practical means of weevil control; to ascertain the extent of increase in territory covered by the weevil during recent years.

Procedure.—This investigation is carried on through two field stations by experiments conducted in conjunction with these stations.

Cooperation.—Entomologist of the State of Utah.

Location.—Salt Lake City, Utah.

Date begun.—1910.

Results.—A satisfactory cultural method of controlling this serious pest has been worked out, and the results are being published as a farmers' bulletin. The work of importing its parasites from Europe has been suspended on account of the abnormal conditions prevailing abroad. Investigations looking to the prevention of the spread of this species are also being conducted.

Assignment.—Geo. I. Reeves.

Proposed expenditures, 1916-17.—\$12,620.

Insects Affecting Cowpeas:

Object.—To collect information relative to all insects attacking cowpeas either above or below ground; to determine the influence on the fertilizing value of the plants of the attack of larvæ on the nitrogenous nodules of the roots.

Procedure.—Methods of investigation similar to those adopted for the investigation of soy-bean insects are followed.

Location.—Charlottesville, Va., Columbia, S. C., Greenwood, Miss., Hagerstown, Md., and Charleston, Mo.

Date begun.—1912.

Insects Affecting Cowpeas—Continued.

Results.—Investigations of *Cerotoma trifurcata*, a small beetle attacking both the leaves and nitrogenous nodules of cowpeas, have been conducted. A fungous disease of the plant has interfered with these investigations, so that it has become necessary to shift the field of operations to another portion of the country. No positive results have as yet been secured.

Investigations of the cowpea weevil during the past year have determined the fact that this insect pest has but one generation in Florida. Some insect parasites of this pest have also been secured.

Probable date of completion.—1918.

Assignment.—Philip Luginbill, C. F. Turner, R. N. Wilson, W. R. McConnell, W. H. Larrimer, G. G. Ainslie.

Proposed expenditures, 1916-17.—\$4,100.

Miscellaneous Forage Insects:

Object.—To investigate outbreaks of miscellaneous insects, as occasion may require, when attacking any crop utilized as forage.

Procedure.—Investigations of the life histories and habits of the insects are made under both field and laboratory conditions for the purpose of discovering the best methods of devising measures for their control. In the grasshopper work studies will be made largely for the purpose of determining the efficacy of arsenicals to be substituted for Paris green, the price of which has risen enormously during the past year.

Location.—Throughout the United States.

Date begun.—1910.

Results.—Extensive investigations of grasshoppers have been conducted and a positive method of control secured. The results of this investigation are summarized in an article published in the Yearbook of the department for 1915. The saving of money to agriculturists as a result of these investigations will undoubtedly be immense. A farmers' bulletin giving full directions for the application of the methods of destroying grasshoppers is in course of preparation.

Progress has been made on the investigation of the green clover worm. Its life history has been practically completed and work on control measures is almost completed. A publication on the subject is in course of preparation.

Work has been partially completed on the widely distributed clover-leaf hopper, and a farmers' bulletin has been prepared giving control measures for the Central States. Life-history studies in relation to forage crops will be continued.

A fairly complete knowledge of the life history of *Epagoge sulfureana*, an insect pest of alfalfa and other plants, has been obtained, but the working out of control measures is still to be accomplished.

The life history and number of generations of *Loxostege similalis*, a small caterpillar, and serious pest of alfalfa in certain portions of the country, have been determined, but control measures are still to be ascertained.

Assignment.—All members of the staff.

Proposed expenditures, 1916-17.—\$3,420.

Total, Forage Insect Investigations, \$47,440, including \$2,940 statutory.

Total, Cereal and Forage Insect Investigations, \$122,420, including \$7,760 statutory.

[Research.]

SOUTHERN FIELD-CROP INSECT INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To direct and supervise the expenditures of the appropriations for southern field-crop insect investigations.

Location.—Washington, D. C.

Date begun.—1909.

Assignment.—W. D. Hunter, W. D. Pierce.

Proposed expenditures, 1916-17.—\$7,500, including \$2,600 statutory.

COTTON INSECT INVESTIGATIONS.**Cotton Boll Weevil:****(a) CONTROL IN SEVERELY INJURED SECTIONS—**

Object.—To relieve the present situation in the Mississippi Valley, where cultural methods of controlling the boll weevil have been of comparatively little value, and also furnish relief in other sections where the damage is very severe.

Cotton Boll Weevil—Continued.

Procedure.—This problem will be approached by experiments in the methods of culture and cultivation with regard to the relation of spacing to weevil injury; the use of poisons, especially lead arsenate; the collection of infested squares and fruit and adult weevils; hibernation studies; field studies to correlate conditions affecting weevil injury; in order to determine the relative influence of different factors; intensive study of characteristics of the different cotton varieties with regard to susceptibility to weevil attack; the relation of time of application of fertilizers to weevil injury; and all other means of promise, until the proper means of control in these sections can be perfected.

Cooperation.—Arrangements have been made with the States Relations Service whereby one agent will be ready to investigate any section when requested and advise as to control measures. Cooperation is maintained with the State experiment stations in Louisiana and Mississippi.

Location.—Tallulah, La., and Thomasville, Ga.

Date begun.—1895 in Texas, 1904 in Louisiana, 1910 in Mississippi, 1916 in Georgia.

Results.—In western Louisiana the control of the boll weevil has brought acreage yields back to almost normal. In the Mississippi delta the work of the last five years has given increased confidence to the planters. Rather definite results have been secured from the use of lead arsenate, which showed a certain amount of profit under some field conditions. Definite results have been obtained from certain methods of collecting infested squares. Careful studies of the farm practices on successful plantations are gradually revealing many points of practical importance.

Assignment.—B. R. Coad.

Proposed expenditures, 1916-17.—\$11,010.

(b) LIFE-HISTORY STUDIES—

Object.—To determine the extent to which the weevil has changed its habits during the period it has existed in the country, and to compare its habits in the newly infested sections with sections infested for a number of years; to study the relation of the condition of weevils entering hibernation in the fall to their vitality and activity in the spring; to ascertain the effect upon the boll weevil of poisons and the manner of ingestion of the same; to determine the relative attractiveness of various chemicals, with the view of finding an attractive chemical which can be poisoned and used as a trap; and to work out the life history of the boll weevil in Sea Island cotton and its relations to Sea Island cotton industries.

Procedure.—In Louisiana the life-history, hibernation, and chemical studies will be very carefully conducted under all possible conditions. These experiments continue a series started at the Tallulah laboratory. At Victoria and Uvalde, Tex., important biological studies will be conducted to compare with the former records. At Thomasville, Ga., studies will be made of the weevil in newly infested areas, especially with regard to its behavior on Sea Island cotton.

Location.—Tallulah, La., Victoria and Uvalde, Tex., Thomasville, Ga., Tucson, Ariz., and Washington, D. C.

Date begun.—1904.

Results.—One of the most important results of the biological studies has been the proof that boll weevils fertilized in the fall are capable of reproduction without further fertilization in the spring. This means that a single female boll weevil in a newly infested section is capable of producing progeny in the spring. Further results have been obtained in determining the capability of the weevil to live on foods other than cotton and to withstand great severities of climate.

Probable date of completion.—In view of the fact that the boll weevil has proven itself an adaptable and changing species, it will probably be necessary to continue the biological studies for several years.

Assignment.—W. D. Pierce, B. R. Coad.

Proposed expenditures, 1916-17.—\$4,820.

(c) STATUS AND DISTRIBUTION—

Object.—To determine prospects for damage early in the season, investigate newly infested sections, and study the effect of environment on possible control; to study the distribution of controlling agencies and the extent of spread and actual losses during the season; to map the area of infestation and distribute warnings of future damage.

Cotton Boll Weevil—Continued.

Procedure.—This project is conducted by inspection trips made throughout the year to all infested sections. The dispersion of the weevil is ascertained during the months of September to December by a thorough investigation of the entire outside limits of the weevil infestation.

Cooperation.—State entomologists of Georgia, Alabama, Florida, Mississippi, Tennessee, Arkansas, Oklahoma, Louisiana, Texas, and Arizona and demonstration agents of the States Relations Service.

Location.—All sections of the cotton belt where the weevil occurs or is reported to occur.

Date begun.—1892.

Results.—The work under this project is conducted from year to year to meet the demand from planters and others for exact information about the status of the weevil. By means of the information secured through this service quarantines against artificial distribution have been inaugurated which have prevented natural spread in several cases, and sporadic occurrences outside of the main infested area have been stopped. The statements issued have been instrumental in determining the course of action of many planters and business men. The usual map showing the spread of the insect was issued.

Assignment.—W. D. Pierce.

Proposed expenditures, 1916-17.—\$3,000.

Cotton Root Aphids:

Object.—To determine means of control.

Procedure.—A thorough study is being made of the life history, food plants, and control of the species attacking the roots of cotton.

Cooperation.—South Carolina Agricultural College.

Location.—Clemson College and Columbia, S. C.

Date begun.—1910.

Results.—Preliminary results have been published through the South Carolina Experiment Station. These results indicate relief through a rotation of crops.

Probable date of completion.—1918.

Assignment.—A. F. Conradi.

Proposed expenditures, 1916-17.—\$450.

Cotton Red Spider:

Object.—To study the distribution and effect upon cotton production of the red spider in various parts of the South.

Procedure.—Incidental observations will be made by various agents in the field at many points in the South.

Location.—Points throughout the cotton belt.

Date begun.—1910.

Results.—The practical work upon the red spider has been brought to completion and a bulletin submitted for publication. Practical methods of control by the use of insecticides and also cultural methods have been devised and thoroughly tested in field experiments.

Probable date of completion.—1917.

Assignment.—F. L. McDonough.

Proposed expenditures, 1916-17.—\$500.

Cotton Insect Injury in the Imperial Valley, Cal.:

Object.—To determine the extent of injury by the cotton thrips and other insects affecting cotton in the Imperial Valley and to perfect methods of control.

Procedure.—An agent will be stationed at some point in the Imperial Valley to make thorough studies of all cotton pests.

Cooperation.—In this work a close touch will be maintained with the agents of the Bureau of Plant Industry and the horticultural commissioners in Imperial County, Cal.

Location.—El Centro, Cal., and other points in the Imperial Valley.

Date begun.—1913.

Results.—A preliminary list of the insects attacking cotton in the Imperial Valley has been prepared, and a man was stationed at El Centro for continuous work in the spring of 1916.

Assignment.—E. A. McGregor.

Proposed expenditures, 1916-17.—\$3,000.

Miscellaneous Insects Affecting Cotton:

Object.—To determine the extent of the well-known shedding of cotton fruit, which may be due to insects that feed upon the blooms; to study the relations of cutworms, aphids, and other insects to the abortive condition of the plants; to determine means of reducing the damage to the squares by cotton fleas and other piercing bugs; to ascertain the relationship between insects and cotton diseases.

Procedure.—A very thorough investigation of the life history of all insects attacking cotton will be made at Thomasville, Ga. The majority of these insects have not been studied critically, and therefore there are no present known means of control. An effort will be made to find the proper and most expedient means of control for each species. Special attention will be given to the insects known as sharpshooters, cotton stainers, and boll-feeding bugs. The parasites of these insects will be studied carefully.

Cooperation.—An arrangement has been made with the Georgia State entomologist for accommodations in the laboratory at Thomasville, Ga., and a cooperative agreement has been made for carrying out studies of the insect transmission of diseases of cotton. Cooperation has also been secured with all State entomologists in the cotton belt with the view of observing the destruction and spread of cotton insects. Through this cooperation the bureau is able to warn the entomologists sometimes months in advance of the time of the spread of serious cotton pests.

Location.—Thomasville, Ga., Victoria, Tex., Calexico and El Centro, Cal., Tucson and Phoenix, Ariz., and Tallulah, La.

Date begun.—1913.

Results.—The principal results obtained under this project have been along the lines of reducing the damage from the cotton-leaf worm and southern grass worm by timely warnings of their approach. A large mass of notes has been gathered on the life histories of many cotton pests, and a complete bibliography of the cotton insects of the world has been prepared to assist in this work. Special experiments were performed to show the importance of various species in the transmission of fungous and bacterial diseases of the cotton plant.

Assignment.—G. D. Smith, W. D. Pierce, J. D. Mitchell, B. R. Coad, E. A. McGregor.

Proposed expenditures, 1916-17.—\$6,000.

Total, Cotton Insect Investigations, \$28,780, including \$3,640 statutory.

TOBACCO INSECT INVESTIGATIONS.**Tobacco Hornworms:**

Object.—To test control measures to reduce losses, especially by the use of powdered arsenate of lead and by improvement of dusting machinery, and thus to further cheapen the methods already recommended.

Procedure.—A sufficiently large force of temporary men will be employed so that experiments can be made on a number of plantations in Kentucky, Tennessee, North Carolina, Virginia, and Florida. The object of these experiments will be to determine the exact methods of applying the poison under the different conditions obtaining in these widely separated districts.

Cooperation.—Tennessee Experiment Station, and growers in Kentucky, Tennessee, North Carolina, Virginia, and Florida.

Location.—Clarksville, Tenn., Quincy, Fla., and points in Kentucky, Tennessee, North Carolina, and Virginia.

Date begun.—1912.

Results.—(1) During 1916: Further improvements have been suggested in the apparatus for the application of the poison, as a result of which it has been possible to make a more thorough application, thereby very materially reducing the cost of combating the insects.

(2) Prior to 1916: The practical value of arsenate of lead used in the powdered form was determined and published. The investigation resulted in finding a better form of arsenate of lead for such work than had previously been used, and very decided improvements were suggested in the apparatus for applying the poison.

Probable date of completion.—Not earlier than 1920.

Assignment.—A. C. Morgan.

Proposed expenditures, 1916-17.—\$19,600.

Cigarette Beetle:

Object.—To determine feasible means of preventing losses in warehouses and factories and to the trade.

Procedure.—Experiments are conducted to test the value of artificial heat and cold, electrical processes, ultra-violet rays, methods of storage, cleanliness in warehouses and factories, fumigants, and carbon bisulphide and hydrocyanic acid gas under pressure and vacuum, with a view to find the best means of control.

Cooperation.—Tobacco dealers, warehouses and factories, manufacturers of different types of electrical apparatus, and the Federal Horticultural Board.

Location.—Clarksville, Tenn., Quincy, Fla., Washington, D. C., and other points.

Date begun.—1910.

Results.—(1) During 1916: It has been found that the cold storage of manufactured tobacco at low temperatures furnishes an efficient and economical means of preventing loss. It has also been found that exposure to Röntgen rays, under certain conditions, is effective in sterilizing the eggs. Experiments in tobacco factories have shown that certain processes used in the manufacture of certain classes of tobacco are effective in killing all stages of the beetle and that later infestation is the result of improper methods of hauling and storing.

(2) Prior to 1916: Experiments have shown that under certain conditions heat may be used in sterilizing warehouses and certain classes of tobacco. The inefficiency of certain sterilizing processes has been determined. The conditions necessary to the success of certain fumigants used in sterilizing tobacco have also been determined. Data have been secured upon the biology of the beetle in several localities.

Probable date of completion.—About 1920.

Assignment.—G. A. Runner.

Proposed expenditures, 1916-17.—\$2,500.

Insect Transmission of Mosaic Disease:

Object.—To determine what insects are capable of transmitting the mosaic disease under different conditions and to devise means of controlling these insects and preventing the spread of the disease through them.

Procedure.—Careful caging of insects which have been placed in contact with the disease will be carried on and an attempt made to ascertain the conditions under which they can transmit the disease to healthy plants. If possible, an investigator will be sent into Maryland and Pennsylvania during the year to make observations and experiments where the disease is most prevalent and injurious.

Cooperation.—Bureau of Plant Industry and Tennessee Experiment Station.

Location.—Clarksville, Tenn.

Date begun.—1913.

Results.—(1) During 1916: No special advance was made owing to inability to secure a man competent to carry on the experiments.

(2) Prior to 1916: It has been determined that the tobacco flea beetle, hornworm, and certain grasshoppers may, under certain conditions, be transmitters of the mosaic disease. It has also been determined that the disease may be carried over winter in the rootstalks of *Physalis* sp.

Probable date of completion.—About 1920.

Assignment.—A. C. Morgan, S. E. Crumb.

Proposed expenditures, 1916-17.—\$2,700.

Miscellaneous Tobacco Insects:

Object.—To determine the possibility of preventing serious losses from miscellaneous insects affecting field-growing tobacco crops, including wireworms, cutworms, flea beetles, and grasshoppers; also losses occasioned by insects to the shade-grown tobacco, particularly those caused by the budworms and thrips, and to further cheapen the cost of fighting these pests; and to investigate methods of controlling miscellaneous insects which cause serious losses to the stored and manufactured product, including the large tobacco beetle, the drug-store beetle, and *Silvanus* sp.

Procedure.—Careful biological studies will be made of tobacco insects which are observed. Methods of control will be tested and observations made upon the effect of general farm practices on injury. The efficiency of trap lights and attractive baits will be determined. In the study of stored-tobacco insects careful biological studies will be made of all the insects observed, and tests of old and new fumigants for their control will be made. The effect of ultra-violet rays will also be tested.

Miscellaneous Tobacco Insects—Continued.

Cooperation.—Tennessee Experiment Station, and tobacco dealers and growers in Kentucky, Tennessee, North Carolina, Virginia, and Florida.

Location.—Clarksville, Tenn., Quincy, Fla., and points in Kentucky, Virginia, and North Carolina.

Date begun.—1910.

Results.—A new poison, used in trap baits for cutworms, wireworms, and grasshoppers, has been tested with very promising results. Valuable data have been secured upon the efficiency of trap lights in connection with insect control. A bulletin upon the biology and control of the wireworm has been published. A key to the species of cutworms affecting tobacco has also been published. A complete bibliography of tobacco insects has been made and is being maintained. It was determined that a special grade of arsenate of lead is far superior to Paris green in fighting the budworm and that the saving due to the use of this insecticide amounts to at least \$30 per acre. Data upon a promising new fumigant of stored tobacco have been secured, and considerable information has been obtained upon the life history of *Silvanus*.

Assignment.—S. E. Crumb, G. A. Runner, A. C. Morgan.

Proposed expenditures, 1916-17.—\$2,400.

Total, Tobacco Insect Investigations, \$27,200, including \$2,440 statutory.

RICE INSECT INVESTIGATIONS.**Rice Water Weevil and Other Rice Insects:**

Object.—To investigate the means of control of rice insect pests.

Procedure.—Trips of investigation are made to various rice-growing regions to determine insect injury and the results of various types of farm practice.

Cooperation.—Louisiana Experiment Station.

Location.—Points in Louisiana, Arkansas, and Texas.

Date begun.—1912.

Results.—The control of the rice water weevil by manipulation of water has been worked out at Crowley, La. The work of the past season consisted of tests of this method on a number of plantations. A large number of notes has been accumulated on the life histories of other rice insects. A complete bibliography of rice insects is maintained at the headquarters at Washington.

Probable date of completion.—1918.

Assignment.—J. L. Webb.

Proposed expenditures, 1916-17.—\$2,000.

SUGAR-CANE INSECT INVESTIGATIONS.**Sugar-Cane Moth Borer:**

Object.—To discover means of controlling the moth borer in sugar cane and corn, especially in adapting cultural practices to the increase of its parasitic enemies.

Procedure.—Thorough experimental work is conducted in Louisiana with all possible means of control. The work has been mainly along the lines of disposition of trash, but this is now being supplemented by the development of a method of control by poisons. One agent collects parasites in Cuba during the summer months and sends them to the laboratory at New Orleans, where they are reared for release in the sugar-cane fields.

Cooperation.—Louisiana Sugar Experiment Station, Audubon Park, New Orleans, La.; Estación Experimental Agronómica, Santiago de las Vegas, Cuba; Belle Alliance Co. (Ltd.), Belle Alliance, La.

Location.—Audubon Park, New Orleans, La.

Date begun.—1910.

Results.—During the fiscal year 1916 preliminary results were obtained, indicating the probable efficiency of control by poisons applied to the leaves of young plants. It was also found that a species of parasite imported from Cuba attacked the moth borer in the cane fields at Audubon Park and bred at least during the latter months of 1916. Previous work indicates a more satisfactory disposition of trash than that now being practiced.

Assignment.—T. E. Holloway, U. C. Loftin.

Proposed expenditures, 1916-17.—\$3,150.

Miscellaneous Insects Affecting Sugar Cane:

Object.—To determine the damage done to sugar cane by miscellaneous insects, including mealy bugs and root borers, and to perfect means of control.

Procedure.—This project is conducted by field examinations, laboratory work, and explorations, as well as by practical experiments.

Miscellaneous Insects Affecting Sugar Cane—Continued.

Cooperation.—Louisiana Sugar Experiment Station, Audubon Park, New Orleans, La., and Estación Experimental Agronómica, Santiago de las Vegas, Cuba.

Location.—New Orleans, La.

Date begun.—1911.

Results.—Information has been obtained as to the means of dissemination of sugar-cane insects and as to parasitic enemies.

Assignment.—T. E. Holloway, U. C. Loftin, E. R. Barber.

Proposed expenditures, 1916-17.—\$1,700.

Total, Sugar-Cane Insect Investigations, \$4,850.

ARGENTINE ANT INVESTIGATIONS.**Argentine Ant Investigations:**

Object.—To reduce losses occurring in cane plantations and orchards and to prevent annoyance in dwellings, warehouses, and elsewhere due to the Argentine ant.

Procedure.—Surveys are made of the territory infested in the Southern States, and experiments are conducted to determine control measures suitable for city and plantation conditions.

Cooperation.—Louisiana Sugar Experiment Station, Audubon Park, New Orleans, La., and the cities of Hattiesburg, Miss., and Augusta, Ga.

Date begun.—1910.

Results.—The control of the Argentine ant in dwellings, warehouses, and under city conditions generally has been worked out, and a report for publication was submitted during the fiscal year 1916. It has recently been found that the Argentine ant is the cause of considerable injury to sugar cane owing to its protection of the sugar-cane mealy bug in such a manner as to cause it to increase very rapidly.

Assignment.—E. R. Barber.

Proposed expenditures, 1916-17.—\$2,750.

Total, Southern Field-Crop Insect Investigations, \$73,080, including \$8,680 statutory.

[Research.]

FOREST AND SHADE-TREE INSECT INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To supervise the field and laboratory investigations and conduct the necessary administrative and office work incident thereto.

Location.—The office and laboratory work is conducted at Washington and the field work at special field stations representing defined sections or districts of the country. The locations of field stations for 1917 are: Colorado Springs, Colo., for the southern Rocky Mountain region; Missoula, Mont., for the northern Rocky Mountain region; Ashland, Oreg., for the Pacific slope; and East Falls Church, Va., for the central and eastern United States. A field laboratory is located at Placerville, Cal.

Date begun.—1902.

Assignment.—A. D. Hopkins.

Proposed expenditures, 1916-17.—\$5,200, including \$1,200 statutory.

FIELD INVESTIGATIONS.**Forest-Reproduction Insects:**

Object.—To determine the character and cause of (a) injuries to the flowers, fruit, and seed on the trees and to the seeds stored or in the ground, and (b) injuries to the roots, stems, branches, and foliage of seedlings, saplings, and nursery stock; and to determine methods of prevention and control.

Procedure.—This is a general project, in which some attention is given to the subject by all members of the staff in connection with their regular field work. The data secured are submitted to the leaders for study, compilation, and publication.

Location.—United States.

Date begun.—1904.

Forest-Reproduction Insects—Continued.

Results.—The general information acquired on this subject renders it possible to give prompt and reliable information on specific questions. Publication issued: Department Bulletin 170, "The European Pine-Shoot Moth; A Serious Menace to Pine Timber in America."

It has been found that a very large percentage of the seed crop of western coniferous trees is destroyed by seed-infesting insects and that losses by collectors and planters through the handling of defective seed can be avoided through the utilization of available information. Data in Department Bulletin 95, "Insect Damage to the Cones and Seeds of Pacific Coast Conifers."

The damage to reproduction pine caused by small caterpillars mining in the tips of new growth, the bark of pine and Douglas-fir saplings, and the base of trees is very serious in some localities, and evidence has been secured that much of this loss can be prevented by proper management of forest nurseries and plantation growth. Data in Department Bulletin 111, "The Sequoia Pitch Moth; A Menace to Pine in Western Montana."

Assignment.—Josef Brunner, J. M. Miller.

Proposed expenditures, 1916-17.—\$7,000.

(Insect Damage to Forest-Tree Seeds: Discontinued as a separate project; included under "Forest-Reproduction Insects.")

(Damage to Reproduction Conifers by Lepidopterous Insects and Pissodes Beetles: Discontinued as a separate project; included under "Forest-Reproduction Insects.")

Relation of Climate to the Periodical Phenomena of Insects and Other Entomological Problems:

Object.—(a) To determine, by means of phenological data on plants and animals, the normal rate of differences in the beginning and ending of periodical phenomena of insects due to differences in altitude, latitude, and longitude, local physical conditions, etc. (b) To investigate the relation of injuries by lightning to the direct cause of the death of trees; subsequent attack by *Dendroctonus* beetles as a cause of death; attack by other insects as the final cause of death; the starting of destructive outbreaks of *Dendroctonus* beetles; the starting of fires from old, dead, lightning-struck or insect-killed trees, and the attraction of destructive insects to near-by healthy trees. (c) To determine the influence of wet and dry seasons and warm and cold winters, windstorms, dry and wet soils, and other physical conditions on the habits and seasonal history of insects.

Procedure.—This is a special project, in which the leader is assisted in the collection of data by all members of the staff in connection with their regular field duties.

Cooperation.—Informally, with the Bureau of Plant Industry and Weather Bureau.

Location.—United States.

Date begun.—1897.

Results.—It has been determined that for animals and plants of the median latitude of the United States there is a general average rate of difference in the periodical events in their life, reproduction, and growth of about 4 days for each degree of latitude, 4 days for each 400 feet of altitude, and 4 days for each 5 degrees of longitude. Studies in the practical application of this law have shown it to be of special importance in planning and conducting control work against forest insects, and that it has a broad application also in periodical farm and garden operations, other lines of biological research, etc. Special progress was made in these investigations in 1915-16, and the results to date are being prepared for publication.

Investigation has shown that lightning rarely kills a tree, unless it shatters it, but that the death of trees slightly injured by lightning is, under favorable conditions, often caused by insects, and that in some cases outbreaks of a destructive insect are thus started. A large amount of data has been collected, which is being prepared for publication.

It has been found that droughts are not favorable or unfavorable to tree-killing insects, that excessively cold winters will kill some insects, and that windstorms often favor insect depredations.

Assignment.—A. D. Hopkins.

Proposed expenditures, 1916-17.—\$4,750.

(Relation of Climatic Conditions to Forest Insect Life: Discontinued as a separate project; included under "Relation of Climate to the Periodical Phenomena of Insects and Other Entomological Problems.")

(**Relation of Latitude and Altitude to the Periodical Phenomena of Insects, Especially Forest Insects:** Discontinued as a separate project; included under "Relation of Climate to the Periodical Phenomena of Insects and Other Entomological Problems.")

(**Relation of Injuries by Lightning to Subsequent Injuries by Insects:** Discontinued as a separate project; included under "Relation of Climate to the Periodical Phenomena of Insects and Other Entomological Problems.")

Interrelation of Insects and Forest Fires in the Destruction of Forests and Damage by Insects to the Wood of Fire-Killed Trees:

Object.—To determine the relation of injuries by insects to subsequent injuries or destruction by forest fires and the relation of injuries by forest fires to subsequent injuries by insects.

Procedure.—This is a general project, in which the leader is assisted in the collection of data by all members of the field force in the area mentioned. It includes studies of injuries by insects to the bark at the base of living trees and of their relation to subsequent fire wounds; the work of wood-boring insects in fire wounds and its relation to extension of injury by subsequent fires; the relation of small and large areas of insect-killed timber to favorable conditions for the starting and spread of forest fires; the extension of fire-wound injuries by wood-boring insects; and the relation of fire-injured and fire-killed trees to subsequent injuries by wood-boring insects to the trunks of trees, to the multiplication of destructive bark beetles, and to the extension of depredations on adjacent uninjured trees by bark beetles and other insects breeding in fire-injured and fire-killed trees.

Location.—Missoula, Mont. (field station). Field of operations, United States.

Date begun.—1899.

Results.—It has been determined that insects are the primary cause of the death of more merchantable-size timber than is caused by forest fires; that the timber killed by insects contributes to the starting and spread of destructive fires, and that, therefore, the control of the destructive insects will contribute to the control of forest fires. Special work on this project has been completed and manuscript for a bulletin on the results has been submitted for publication. It has been determined that very great losses are caused by this class of insects, and that, through a proper application of the results of investigations already made, a large percentage of such losses can be prevented.

Probable date of completion.—1916.

Assignment.—Josef Brunner.

Proposed expenditures, 1916-17.—\$1,500.

(**Interrelation of Insects and Forest Fires in the Destruction of Forests:** Discontinued as a separate project; included under "Interrelation of Insects and Forest Fires in the Destruction of Forests and Damage by Insects to the Wood of Fire-Killed Trees.")

(**Insect Damage to the Wood of Fire-Killed Trees:** Discontinued as a separate project; included under "Interrelation of Insects and Forest Fires in the Destruction of Forests and Damage by Insects to the Wood of Fire-Killed Trees.")

Insects Injurious to Forest Products:

Object.—To determine the character, cause, and extent of injuries to crude, finished, and utilized forest products and methods of preventing losses; the relative immunity of different species of wood to attack by termites; the relative efficiency of chemical preservatives in the treatment of cabinet and other woods against attack by termites and other wood-boring insects; the relative efficiency of chemical preservatives and methods against insect attack on wood set in the ground; the character and extent of the damage caused by termites and practical methods of prevention and control; powder-post injury to seasoned forest products; and damage to poles, posts, mine props, railroad ties, and similar forest products by wood-boring insects.

Procedure.—This is a general project, in which, in addition to the investigations conducted by the leaders, some attention is given to the subject by all members of the staff in connection with their regular field work. The data obtained are submitted to the leaders for study, compilation, and publication. It includes studies of the character and cause of injuries to recently felled trees, saw logs, round timber, rough timber, and other unseasoned crude products; injuries to seasoned rough and dressed lumber and finished wood material; injuries to construction timbers and other timbers and other wood material used in buildings, bridges, railroad construction, mining, etc.; injury to stored oak and hemlock bark for tanning purposes; injuries to medicinal bark, roots, leaves, etc.; and experiments to determine methods of preventing losses.

Insects Injurious to Forest Products—Continued.

Cooperation.—Informal cooperation with manufacturers and utilizers of forest products.

Location.—East Falls Church, Va. (field station). Field of operations, United States; Central and South America, through correspondence.

Date begun.—1902.

Results.—The results of extensive investigations and experiments with wood preservatives on different kinds of wood have shown that a large percentage of the serious losses heretofore suffered can be prevented and that the methods recommended are being put into practice. The Army and Navy have adopted the department's recommendations in regard to powder post for their storehouses, and leading manufacturers all over this country are profiting by the information disseminated. As a result of detailed study and experiments with poles set in the ground and in mines, railroad, telephone, telegraph, and mining industries are adopting and putting into practice the methods recommended, with most gratifying results. Publications issued: Bureau of Entomology Bulletin 58, Part V, "Insect Depredations in North American Forests and Practical Methods of Prevention and Control"; Bulletin 94, Part II, "Insects Injurious to Forests and Forest Products," "Biology of the Termites of the Eastern United States, with Preventive and Remedial Measures"; Circular 128, "Insect Injuries to Forest Products"; Circular 134, "Damage to Telephone and Telegraph Poles by Wood-Boring Insects"; Circular 156, "Insect Damage to Mine Props and Methods of Preventing the Injury"; Department Yearbook for 1904, "Insect Injuries to Forest Products"; and Department Bulletin 333, "Termites, or 'White Ants,' in the United States: Their Damage and Methods of Prevention."

Assignment.—A. D. Hopkins, T. E. Snyder, F. C. Craighead.

Proposed expenditures, 1916-17.—\$3,090.

Hickory Insects:

Object.—To make a thorough study of all insects found to affect the different species of hickory, to determine the cause of the extensive dying of hickory and of injury to its products, and to develop methods of controlling the primary enemies of the tree and of preventing losses of the crude and stored commercial products of wood and nuts.

Procedure.—This is a general project, in which the leaders are assisted in the collection of material by other members of the field force in the area mentioned and by the systematists at Washington in the identification of species. It includes the collection of material of all stages of the insects and their work, with full field notes on observations, experiments with trap trees, natural enemies, and other methods of control, and also systematic work on the classification and description of species. Special attention is being given to the hickory bark beetle in connection with its depredations on the hickories of Long Island, New York, with special reference to community cooperation in carrying on the proper control measures. So far some thousands of trees have been treated according to our recommendations and instructions, and special interest is manifested by property owners in the problem.

Location.—Eastern United States.

Date begun.—1902.

Results.—The seasonal history of the hickory bark beetle has been completed, and as a result of information disseminated through publications and correspondence this most destructive enemy of the hickory trees of the eastern United States is being brought under control.

Probable date of completion.—1918.

Assignment.—A. D. Hopkins, W. S. Fisher, A. B. Champlain, L. C. Griffith.

Proposed expenditures, 1916-17.—\$3,000.

Ash Insects:

Object.—To make a thorough study of the insects of different species of ash, determine the cause of injuries to the tree and its products, and develop methods of controlling the primary enemies and of preventing losses of the crude and stored commercial products.

Procedure.—Same as preceding project.

Location.—United States.

Date begun.—1904.

Results.—It has been determined that the damage to ash trees and their crude and finished products caused by wood-boring insects is very extensive and that much of this loss can be prevented.

Ash Insects—Continued.*Probable date of completion.*—1920.*Assignment.*—A. D. Hopkins, T. E. Snyder, F. C. Craighead.*Proposed expenditures, 1916-17.*—\$1,200.**Economic Investigations of the Scolytid Bark and Timber Beetles of North America:***Object.*—To determine the character and extent of damage caused by these insects to forest growth and forest products, the seasonal histories and habits of the principal species, and practical methods of preventing losses from their attacks.*Procedure.*—This is a general project, in which the leader is assisted by other members of the field force in connection with their regular field duties, and includes the collection of material of all stages of the insects and their work, with full field notes on observations relating to seasonal histories, habits, and methods of control, experiments with natural enemies, and verification of results. These data are submitted to the leader for study, compilation, and publication.*Cooperation.*—Department of the Interior; in the investigation and verification of results of practical control work against the *Dendroctonus* beetles in the national parks.*Location.*—United States.*Date begun.*—1890.*Results.*—The results of investigations of methods of controlling depredations by bark beetles in the coniferous forests of North America have made it possible to discover and recommend practical methods of protecting national, State, and private forests from their most destructive insect enemies. This alone results in a saving of not less than \$10,000,000 annually in the value of timber protected, at little or no first cost. One of the principal results is the discovery by the leader of a percentage principle of control by which, through the disposal of 25 to 75 per cent of the infestation by *Dendroctonus* beetles, these pests are brought under complete control. This principle has been successfully established in more than 20 demonstration projects, involving hundreds of thousands of acres of infested forests. Many publications have been issued giving results of the investigations.

Special progress during the fiscal year 1916 has been made in the determination of new facts and in the accumulation of facts and evidence which have served to completely establish the practical value and economy of the percentage principle of control and to indicate that two or three more principles in control work are of similar importance, namely, (a) the selection principle, under which a species which breeds in two or more hosts will prefer to continue to breed in the host to which it has become adapted; (b) the principle of vital attack by tree-killing insects, under which the insects have become more or less adjusted in their seasonal history to a maximum development, emergence, and attack during the more vital period in the seasonal history of the host tree species.

Extensive investigations will be continued in 1916-17 at the Ashland, Missoula, Colorado Springs, and Falls Church stations.

Assignment.—A. D. Hopkins.*Proposed expenditures, 1916-17.*—\$5,500.**Economic Study of Forest Buprestidæ, or Flat-Headed Borers:***Object.*—Same as preceding project.*Procedure.*—Same as preceding project, except that this is a special project.*Location.*—Placerville, Cal. (field laboratory). Field of operations, United States.*Date begun.*—1904.*Results.*—It has been determined that some of the flat-headed borers are primarily destructive to living trees, while others contribute to the death of weakened trees or are destructive to the wood of living and dead timber, and that a large percentage of the losses can be prevented through a practical application of the information already acquired and published. Special progress has been made in this line of investigation and the manuscript for a bulletin has been submitted for publication.*Assignment.*—H. E. Burke.*Proposed expenditures, 1916-17.*—\$1,000.

Economic Study of Forest Cerambycidae, or Round-Headed Borers:

Object.—Same as preceding project.

Procedure.—Same as preceding project, except that this is a special project.

Location.—East Falls Church, Va. (field station). Field of operations, United States.

Date begun.—1904.

Results.—The results of a special study of this class of bark and wood borers have shown that they are far more destructive than was heretofore supposed. Special progress has been made in seasonal history studies, which suggest practical methods of preventing losses. A publication has been issued entitled "Larvæ of the Prioninæ—Contributions toward a Classification and Biology of the North American Cerambycidae."

Special progress has been made in this line of investigation in the discovery of new facts about the insects and new methods of control, including the discovery that the addition of 5 per cent of sodium arsenate to solutions of kerosene emulsion is, so far as tried, effective against young stages of bark and wood-boring insects. Extensive experiments have been started to determine additional facts of economic importance, including the testing of new methods of control.

Assignment.—F. C. Craighead.

Proposed expenditures, 1916-17.—\$2,500.

Economic Study of Beneficial Forest Insects:

Object.—To determine the character and extent of beneficial influences of parasitic and predatory insects, their seasonal histories and natural enemies, and methods of propagating and encouraging their beneficial work; and to secure the importation of foreign species and the artificial dissemination of native species.

Procedure.—Same as preceding project, except that this is a general project.

Location.—East Falls Church, Va. (field station). Field of operations, United States.

Date begun.—1903.

Results.—Many new facts have been determined regarding the principal parasitic and predacious insects which are the natural enemies of injurious insects, and this information has been of special importance in connection with the practical application of artificial methods of control.

Assignment.—A. D. Hopkins, A. B. Champlain, S. A. Rohwer, Adam Boving.

Proposed expenditures, 1916-17.—\$1,870.

Bark Lice of the Genus Chermes:

Object.—The determination of systematic and bionomic facts relating to the species of Chermes which infest the bark of coniferous and other forest trees, with special reference to the species involved, their life history and habits, and methods of combating them.

Procedure.—Same as preceding project.

Location.—United States.

Date begun.—1908.

Results.—It has been found that this class of insects, each species of which lives alternately on two different species of trees, making galls on the twigs of spruce and infesting the twigs and bark of pine, is of special economic importance. It has been discovered that if nursery and ornamental trees are sprayed with kerosene emulsion at the time new growth starts on the twigs it will protect the trees from damage by this class of insects. Special progress has been made in this line of investigation, especially on the species affecting western conifers, including the discovery of many new facts.

Assignment.—A. D. Hopkins, J. H. Pollock.

Proposed expenditures, 1916-17.—\$500.

Agrilus Beetles:

Object.—To investigate the relation of Agrilus beetles to (a) the direct death of trees, (b) trees injured by disease, (c) trees defoliated by insects, (d) trees the roots of which have been injured by insects or other agencies, (e) trees struck by lightning or injured from other causes, and (f) stumps of trees felled during the winter; to determine the seasonal histories and habits of the beetles, general and local; to determine the natural enemies of different stages of Agrilus beetles and the relation of such enemies to natural control; to conduct investigations and experiments looking to a determination of practical methods of control and prevention of depredations by the various species of Agrilus on forest-tree growth.

Agrilus Beetles—Continued.

Procedure.—Same as preceding project. Particular attention is being directed to a study of the relation of these insects to the death of forest and shade trees on Long Island, with special reference to the two-lined chestnut borer and the extensive dying of the oaks.

Location.—East Falls Church, Va. (field station), Placerville, Cal. (field laboratory), and Long Island, N. Y. Field of operations, United States.

Date begun.—1913.

Results.—It has been found that many of these beetles are very destructive to many kinds of trees and as secondary enemies to trees weakened by other insects or disease are often more important than the primary enemy and as a rule may be more readily controlled. The seasonal histories of some of the more important species have been worked out and important new facts determined in regard to their habits. Many new undescribed species of the insect enemies of the beetles have been discovered and their habits studied. With a knowledge of these natural enemies, artificial measures can be employed in such a manner as to get the best results with the least cost.

Probable date of completion.—1920.

Assignment.—A. D. Hopkins, H. E. Burke, A. B. Champlain, W. S. Fisher, S. A. Rohwer, L. C. Griffith.

Proposed expenditures, 1916-17.—\$3,000.

Relation of Mistletoe on Living Trees to Attack by Insects:

Object.—To determine (a) whether trees infested by mistletoe are more subject to attack by bark-boring insects than trees not so affected; (b) whether trees weakened by mistletoe contribute to the increase of tree-killing insects; and (c) the relation of this subject to the general problem of insect control.

Procedure.—Same as preceding project. Special work on this subject has been completed, but it will be continued as a general project.

Location.—Placerville, Cal. (field laboratory). Field of operations, Pacific slope and Rocky Mountain regions.

Date begun.—1913.

Results.—Heretofore it has been thought that trees infested by mistletoe were more subject to attack by tree-killing insects than trees not so infested. Investigations so far indicate that this is not the case.

Probable date of completion.—1916.

Assignment.—H. E. Burke.

Proposed expenditures, 1916-17.—\$250.

Insect-Control Instructions and Demonstrations in the National Parks:

Object.—To give instructions on the essential practical details and to conduct demonstration projects on the control of Dendroctonus beetles in national parks, in accordance with principles and methods recommended by the Department of Agriculture.

Procedure.—This is a special demonstration and instruction project, in which the Department of the Interior details park rangers to the Bureau of Entomology to receive instructions from an entomological ranger of the Department of Agriculture, who has been trained as an expert on the practical details of cruising and locating infested timber and in the application of measures advised by the leader of this project. The instructions relate specifically to (a) methods of cruising to locate the infested timber requiring treatment, (b) the essential practical details of conducting the work of control and protection against Dendroctonus beetles, (c) the inspection of areas in which control work has been done, (d) the location of areas requiring treatment, (e) estimating the character and extent of insect-killed or infested timber, and (f) such other matters pertaining to the practice of forest entomology as may be deemed necessary. All entomological matters except the minor questions that can be handled by the insect-control expert will be referred by him either to a local entomological expert of the Branch of Forest Insects, Bureau of Entomology, or to the chief of the branch at Washington for advice or recommendations. The Bureau of Entomology pays the salary of the entomological ranger. The Department of the Interior pays his traveling and field expenses and also the salaries and expenses of the park rangers assigned to the work and the expenses of all cruising and control operations. When the park rangers are sufficiently trained and qualified, they are to be designated as insect-control rangers and assigned to a national park to work under the immediate supervision of the park supervisor or superintendent.

Insect-Control Instructions and Demonstrations in the National Parks—Continued.

The attention to this subject in 1916-17 will be mainly in the line of recommendations and instructions based on information furnished by park officials, and the training of rangers sent to the field stations by the Interior Department.

Cooperation.—Department of the Interior.

Location.—Washington, D. C., and Yosemite Park for 1916-17.

Date begun.—1913.

Results.—The work done in 1913, 1914, and 1915 has yielded most gratifying results in verifying and demonstrating the practicability and efficiency of the percentage principle of control. The Yosemite Valley is now practically free from damage, and the depredations on the Hetch Hetchy watershed, where a vast amount of timber has been killed during the past 10 or more years, are now under control.

The work done in 1915 resulted in the training of a park ranger in the practical details of control work and the determination that former control work has contributed to almost complete control in all of the areas worked.

Probable date of completion.—1920.

Assignment.—A. D. Hopkins, J. M. Miller, Josef Brunner, W. D. Edmonston.

Proposed expenditures, 1916-17.—\$200.

Investigation of Insects Affecting Shade Trees and Hardy Shrubs:

Object.—To determine (a) the general character and extent of damage by insects to the trees and shrubs of public and private grounds, including municipal parks, streets, and cemeteries, country roads, private parks, national cemeteries, etc., (b) additional facts on the seasonal histories and habits of the insects involved, and (c) additional facts on practical methods of prevention and control; to conduct experiments, and finally to give advice through correspondence, publications, and otherwise on the principles and methods of control to meet the requirements of specific insects and local conditions.

Procedure.—This is a general project, to which all of the time of an assistant leader will be devoted to conducting the supervisory and investigational work, all members of the regular field and laboratory force giving more or less time to the collection of material and the study and identification of insects. The small allotment of funds available for this work renders the field of operations so limited that very little can be accomplished except along restricted lines.

Cooperation.—Some informal cooperation will be invited with municipalities, Federal and State officials, and owners of private parks and grounds, looking to their adoption of the most economical and effective methods of prevention and control, the conduct of experiments with new methods, and the verification of results in practice.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Recent observations and inquiries indicate that the amount of money expended by municipalities and wealthy owners of private grounds and parks each year on useless or improperly applied methods of combating insects affecting shade trees and ornamental shrubs represents a greater loss than that caused directly by the insects. Observations and experience also indicate that, if the proper methods of prevention and control are adopted and carried out in accordance with advice from the most reliable sources, the waste of money and the damage and annoyance from the insects will be reduced to a minimum. Special attention has been given to the shade-tree problems on Long Island, New York, with special reference to the hickories and oaks.

Assignment.—A. D. Hopkins, L. C. Griffith.

Proposed expenditures, 1916-17.—\$2,000.

Total, Field Investigations, \$37,360, including \$4,760 statutory.

LABORATORY INVESTIGATIONS.

Forest and Other Scolytidæ:

Object.—To (a) determine, classify, and describe the genera, species, and stages of development which are new to science; (b) revise and bring up to date the systematic knowledge of all North American species; (c) investigate problems relating to anatomy, taxonomy, terminology, and nomenclature; (d) determine seasonal histories, food and breeding habits, geographical distribution, and such other information of a technical nature about the species as is essential to the best success in the investigation and practical treatment of economic problems.

Forest and Other Scolytidæ—Continued.

Procedure.—This is a special project, in which specimens of all stages of the insects and their work are collected by the leader and members of the force in connection with their regular field duties from all parts of the United States or are received by exchange or for identification from all parts of the world. These specimens are labeled, classified, and preserved in a separate collection in the National Museum with the collection of forest insects under the custodianship of the leader. Such time as can be spared from the regular administrative duties is devoted to a systematic study of the material and the literature on the subject and to the preparation of manuscript for permanent record and publication.

Location.—Washington, D. C.

Date begun.—1902.

Results.—The results of the systematic work on this group of insects have shown that previous to the leader's work on this group nothing whatever had been known of a large number of the most destructive insect enemies of North American forest trees. The information acquired has made it possible to study their exact economic relations to the trees and to discover practical methods of control and prevention. The value of the results of this work alone may be estimated in tens of millions of dollars toward the practical conservation of the forest resources of the United States. The collections are the largest in the world, and specimens are sent here from many other countries for authentic identification. The following paper was published within the past year: "A New Genus of Scolytoid Beetles," *Journal of the Washington Academy of Sciences*, vol. 5, No. 12. Other results are reported in *Proceedings of the United States National Museum*, vol. 48, pp. 115-136, "List of Generic Names and their Type Species in the Coleopterous Superfamily Scolytoidea"; *Bureau of Entomology Technical Series 17, Part II*, "Contributions Toward a Monograph of the Scolytid Beetles," "Preliminary Classification of the Superfamily Scolytoidea"; and Report No. 99, Office of the Secretary, "Classification of the Cryphalinae, with Descriptions of New Genera and Species."

Owing to the pressure of supervisory work and the investigations of subjects relating to the economic projects, very little progress has been made on the systematic work.

Assignment.—A. D. Hopkins.

Proposed expenditures, 1916-17.—\$1,500.

Forest and Other Buprestid Larvæ:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Location.—Placerville, Cal. (field laboratory). Field of operations, United States.

Date begun.—1904.

Results.—Heretofore practically nothing was shown of the systematic characters by which the larvæ of various species of this class of insects could be identified, and without this knowledge very little could be accomplished in the study of seasonal histories and habits, and practically nothing could be done toward the discovery of effective methods of control. Special progress has been made in this work in the discovery of new facts of economic importance. A manuscript giving some of the results of the work of the preceding year has been submitted for publication.

Assignment.—H. E. Burke.

Proposed expenditures, 1916-17.—\$1,500.

Forest and Other Cerambycid Larvæ:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Location.—Washington, D. C. Field of operations, United States.

Date begun.—1904.

Results.—Exceptional progress has been made in the investigation of these larvæ. While they are of great economic importance, very little was known about them a few years ago. Now more than 250 species have been identified and a fund of information acquired of great scientific and economic value. Publications issued: Office of the Secretary Report 107, "Larvæ of the Priioninæ—Contributions toward a Classification and Biology of the North American Cerambycidae."

Assignment.—F. C. Craighead.

Proposed expenditures, 1916-17.—\$1,500.

Forest Hymenoptera:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Location.—Washington, D. C. Field of operations, United States.

Date begun.—1909.

Results.—The results of systematic work on this group of insects, which includes both injurious and beneficial species, are of special scientific and economic importance. Without the knowledge gained from such a study it would be impossible to arrive at definite conclusions as to the relation of the beneficial insects to natural control or to profit by their beneficial influence in connection with the practice of artificial methods of combating insects. Many publications have been issued during the past year in the Proceedings of the United States National Museum and other technical journals.

Assignment.—S. A. Rohwer, William Middleton.

Proposed expenditures, 1916-17.—\$2,000.

Forest Lepidoptera:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Location.—Washington, D. C. Field of operations, United States.

Date begun.—1912.

Results.—Until recent years this important group of forest insects had been almost neglected in this country, but now that a specialist is working on it rapid progress is being made and information acquired which is of fundamental importance to the field investigations of economic problems. Large additions have been made to the collection. Some discoveries of special scientific and economic importance were made during the past year.

Assignment.—Carl Heinrich, J. J. De Gryse.

Proposed expenditures, 1916-17.—\$1,500.

Forest Coleoptera:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Location.—Washington, D. C.

Date begun.—1912.

Results.—This group of insects is represented by more species of economic importance than any other, and therefore requires special study and the proper arrangement and care of the collections, in which gratifying progress has been made.

Assignment.—W. S. Fisher.

Proposed expenditures, 1916-17.—\$2,270.

Forest Diptera:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Location.—Washington, D. C.

Date begun.—1912.

Results.—Very little has been known of this group of insects in their relation to forest growth in America; hence the necessity of systematic work as a basis for economic investigations. Some important discoveries have been made during the past year and a large number of specimens added to the collection.

Assignment.—C. T. Greene.

Proposed expenditures, 1916-17.—\$2,000.

Forest and Other Isoptera:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Location.—Washington, D. C. Field operations, United States.

Date begun.—1912.

Results.—The results of work on the white ants of North America have shown that they are of special economic importance, causing, as they do, great damage to buildings, poles, posts, construction timber, etc. It has been found that there is special need for detailed systematic study of the species as a basis for effective economic work. Publications issued: Bureau of Entomology Bulletin 94, Part II, "Insects Injurious to Forests and Forest Products: Biology of the Ter-

Forest and Other Isoptera—Continued.

mites of the Eastern United States, with Preventive and Remedial Measures"; and Department Bulletin 333, "Termites, or 'White Ants,' in the United States; Their Damage and Methods of Prevention."

Assignment.—T. E. Snyder.

Proposed expenditures, 1916-17.—\$1,500.

Forest and Other Coleopterous Larvæ:

Object.—Same as preceding project.

Procedure.—Same as preceding project.

Location.—Washington, D. C.

Date begun.—1913.

Results.—Practically nothing has been known of the immature stages of even the common beetles which infest the forest trees of this country and their products.

The results so far attained show the absolute necessity of this work as a basis for economic investigations. Most gratifying progress has been made during the past year, and several important papers have been published.

Assignment.—Adam Boving.

Proposed expenditures, 1916-17.—\$2,500.

Total, Laboratory Investigations, \$16,270, including \$2,100 statutory.

Total, Forest and Shade-Tree Insect Investigations, \$58,830, including \$8,060 statutory.

[Research.]

TRUCK-CROP AND STORED-PRODUCT INSECT INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To supervise and direct research projects, including general office routine, laboratory, and field work incidental thereto.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—F. H. Chittenden.

Proposed expenditures, 1916-17.—\$7,310, including \$3,860 statutory.

INVESTIGATION OF TRUCK-CROP INSECTS.**Potato Insect Investigations:****(a) POTATO-TUBER MOTH—**

Object.—To complete investigations of control measures against the potato-tuber moth, investigate its continued spread and probable distribution, and transmit to quarantine officials information in regard to appropriate measures for the prevention of its general widespread distribution.

Procedure.—Through correspondence and field observations the additional spread of this pest will be noted and observations made with reference to its transmission to new fields of infestation and its eradication in interstate shipments of tubers. Since the work has been largely closed up during the past year, it is regarded as unnecessary to continue the assignment of this subject as a primary project and major work will be discontinued.

Location.—Pasadena, Cal., and Norfolk, Va.

Date begun.—1912.

Results.—During the fiscal year 1916 the investigation of the life history, parasites, and control measures for this pest were practically completed and require only slight additional study. It has been found that in normal seasons the potato-tuber moth is so well controlled by natural enemies that by the application of improved cultural methods and the proper storage of potatoes the loss from this insect may be almost entirely obviated. An extensive publication on the subject has now gone to press, and this project may be considered as practically terminated with the present fiscal year.

Assignment.—B. L. Boyden.

Proposed expenditures, 1916-17.—\$500.

(b) COLORADO POTATO BEETLE AND GENERAL POTATO INSECT PESTS—

Object.—To secure additional information with regard to the numerous enemies of the potato, such as the Colorado potato beetle, potato flea-beetle, potato stalk-weevil, potato leafhopper, white grubs, and wireworms. It is particularly desirable to continue a campaign in the South, in which insecticides applicable for use in countries of extreme precipitation or moisture, such as

Potato Insect Investigations—Continued.

the Louisiana delta, may be undertaken. The spread of the Colorado potato beetle on the Pacific coast will also be investigated, and in Michigan studies will be made of white-grub and wireworm control.

Procedure.—At the various field stations of this bureau practical control experiments with new and standard insecticide preparations are being made and additional points in the life history of the pests investigated, and tests of new insecticide machinery are under way.

Cooperation.—Virginia Truck Experiment Station and the Louisiana Experiment Station.

Location.—Baton Rouge, La., Michigan, and southeastern Virginia.

Date begun.—1907.

Results.—In the past the Colorado potato beetle has been unrestricted in some regions because of the lack of the application of appropriate scientific remedies, and injury has, on this account, been considerable. Although many years ago the Bureau of Entomology directed proper methods of control, correspondence constantly received indicates that this matter is still misunderstood. The conditions incident to the European war have also rendered such compounds as Paris green almost prohibitive in price. On this account other and cheaper insecticides are recommended. A paper entitled "Life-History Studies of the Colorado Potato Beetle" has been published in the Journal of Agricultural Research, vol. 5, No. 20, covering additional facts regarding the life history of this insect not hitherto known.

Assignment.—T. H. Jones, F. A. Johnston, D. E. Fink.

Proposed expenditures, 1916-17.—\$3,500.

Onion Insect Investigations:

Object.—To obtain information regarding various onion insects, with special reference to root-maggot injury, and to study the methods of hibernation, alternate food plants, natural enemies, and life histories of the serious insect pests of onions.

Procedure.—The life histories of onion pests are worked out under field and laboratory conditions, and practical applications of insecticidal materials, repellents, etc., are made, in order to furnish information as to those most useful.

Cooperation.—Wisconsin Agricultural Experiment Station.

Location.—South Texas, Stark County, Ind., eastern Colorado, and Wisconsin.

Date begun.—1907.

Results.—A thorough study of the onion thrips has been made and complete results are available for publication. With regard to this pest, it is estimated that \$1,000,000 was saved to the onion growers of northern Indiana through the application of control measures devised and demonstrated by members of the staff of the Bureau of Entomology. Tests of various materials suitable for repellents against the onion maggot and other root-maggots were made experimentally in Wisconsin during the past fiscal year, but this project will require considerable further study, since the problem is peculiarly difficult.

Probable date of completion.—1920.

Assignment.—M. M. High, N. F. Howard, H. O. Marsh.

Proposed expenditures, 1916-17.—\$3,000.

Crucifer Insect Investigations:

Object.—To continue investigations of life history and control measures applicable to the cabbage looper, Southern cabbage webworm, and various aphides and thrips and of their attack on cruciferous crops, such as cabbage, cauliflower, and turnip; and to complete studies being made of the vulnerable points in the life history of the harlequin cabbage bug, root-maggots, the cabbage flea-beetles, and other cabbage pests.

Procedure.—Extensive investigations are being made in districts which grow cole crops commercially, and studies of the life histories and methods of control of the more serious pests encountered are being made, especially with reference to the application of remedial measures in the field, and to the determination of the most effective insecticides and the time they may be applied to the best advantage. The introduction of natural enemies of crucifer insects is being undertaken, and control by the application of repellents and cultivation is demonstrated.

Cooperation.—Virginia Truck Experiment Station and Wisconsin Experiment Station.

Location.—Norfolk, Va., Brownsville, Tex., and Madison, Wis.

Date begun.—1907.

Crucifer Insect Investigations—Continued.

Results.—Control experiments of the root maggots attacking cauliflower through the use of newly devised repellents have yielded promising results. The cabbage aphid is almost completely under control in Virginia as a result of the introduction of beneficial ladybirds. The control of the cabbage looper, the imported cabbage worm, and the onion thrips in its occurrence on cabbage, has also been effected, and the rôle of cabbage as an alternate host plant for the onion thrips has been definitely ascertained. These results are being adapted for practical use in cabbage-growing sections of the United States.

Assignment.—D. E. Fink, M. M. High, N. F. Howard.

Proposed expenditures, 1916-17.—\$3,000.

Investigation of Pea Aphid:

Object.—To obtain further information with regard to the control of the pea aphid on large commercial plantings of peas.

Procedure.—Well-equipped field laboratories have been established in Michigan and in southern Virginia for the study of appropriate control measures through the application of contact insecticides and the encouragement of natural enemies.

Cooperation.—Hart Cannery, Hart, Mich.

Location.—Hart, Mich., and southern California.

Date begun.—1907.

Results.—The life history of the pea aphid has been thoroughly understood for some time in regard to its occurrence in small market gardens, and measures for its control are readily and successfully applied, but on large commercial plantings of peas, especially when sown broadcast, the investigation has not been completed and will require additional attention. Opportunity for the completion of these experiments was lacking during the past year, since natural conditions prevented serious economic injury by aphides to peas.

Probable date of completion.—1918.

Assignment.—F. A. Johnston, R. E. Campbell.

Proposed expenditures, 1916-17.—\$2,000.

Cucurbit Insect Investigations:**(a) INSECTS WHICH TRANSMIT CUCUMBER DISEASES—**

Object.—To investigate the insects injurious to cucumber and related crops and to develop and test methods of control, particular attention to be given to those insects which transmit the infection of bacterial wilt, mosaic, and other diseases; and to cooperate with the Bureau of Plant Industry in an investigation of the transmission by insects of such diseases.

Procedure.—Laboratory and field work is to be conducted at three stations in conjunction with experiments of the Bureau of Plant Industry, as follows: Madison, Wis., Big Rapids, Mich., and Plymouth, Ind. The project relates at its present stage mainly to troubles affecting cucumbers grown for pickling in the Great Lakes region. Experimental plats of approximately 1 acre each for the test of different insecticides will be established at each of the stations, where it is proposed that a series of spray tests with different chemicals will be conducted in order that the most effective insecticide and the one causing the least injury to the plants may be selected for future demonstration. More extensive field demonstrations of insect and disease control will be carried out in cooperation with the Bureau of Plant Industry. An assistant will be placed at each station to help in the recording of results from the plat work and in the application of sprays to the larger fields.

Cooperation.—Wisconsin Experiment Station, H. J. Heinz Co., Bureau of Plant Industry, and individual growers.

Location.—Big Rapids, Mich., Plymouth, Ind., and Madison, Wis.

Date begun.—1916.

Results.—This is a new project, and is to be conducted under special appropriation for the fiscal year 1917.

Assignment.—N. F. Howard, C. H. Popenoe, F. A. Johnston.

Proposed expenditures, 1916-17.—\$5,000.

(b) MELON APHIS AND RELATED FORMS—

Object.—To devise a cheap and effective method of controlling the melon aphid on large commercial plantings of cucumber and muskmelon.

Procedure.—Since the life history of the melon aphid has been previously the subject of publication, present experiments are intended to deal chiefly with control measures applicable to large irrigated fields in the Southwest. Applica-

Cucurbit Insect Investigations—Continued.

tions of new and standard insecticides are being made with high-pressure engine-driven machinery, with a view to procure thorough distribution of contact insecticides over infested plants.

Cooperation.—Virginia Truck Experiment Station.

Location.—Brownsville, Tex., Norfolk, Va., Rocky Ford, Colo., and southern California.

Date begun.—1908.

Results.—Nicotine sulphate in combination with soaps has been found a cheap and effective remedy for the control of the melon aphid on small plats. Special machinery has been devised for the practical application of insecticides at extreme high pressures, so that colonies previously protected by the leaves may be treated. The introduction of ladybirds or lady beetles has proved an effective remedy in some regions. A publication covering the more important details of a biological nature and the remedies most readily applicable will soon be issued.

Assignment.—M. M. High, D. E. Fink, B. L. Boyden, H. O. Marsh.

Proposed expenditures, 1916-17.—\$1,000.

(c) PICKLE AND MELON WORMS—

Object.—To obtain information regarding the life histories and means of control of the pickle worm, melon caterpillar, and related species with somewhat different habits which injure with only slight infestation entire crops in the South.

Procedure.—The usual methods adopted for the investigation of injurious insect pests are practiced. Included in life-history studies are investigations of the effect of climatic conditions and natural enemies on the multiplication of these insects, which are more or less irregular and local in their attacks northward. Control experiments include the planting of trap crops and the testing of spraying methods.

Cooperation.—Virginia Truck Experiment Station and Louisiana Experiment Station.

Location.—Tidewater Virginia, Baton Rouge, La., Washington, D. C., and neighboring regions in Virginia and Maryland.

Results.—This project was begun on a small scale in 1909 in southern Florida but was not completed. Local work has been accomplished in Virginia and Maryland, where the practical prevention of injury to the fruits has been accomplished. The project is practically being reestablished as a primary one, because the insects frequently destroy 75 to 95 per cent of all melons in commercial fields. Manuscripts are being prepared for publication.

Assignment.—T. H. Jones, D. E. Fink, W. H. White.

Proposed expenditures, 1916-17.—\$500.

(d) GENERAL CUCURBIT INSECTS—

Object.—To conduct further investigations in the life histories of the squash bugs, squash-vine borer, squash ladybird, and the various cucumber beetles; and to carry on experiments, on a commercial scale, in control measures which have proven successful against these pests in small plat trials.

Procedure.—The usual methods of scientific investigation regarding life histories, habits, and economic treatment are followed. Experimental control having been demonstrated on small plats, larger areas will be covered in an effort to apply valuable information to practical results.

Location.—Baton Rouge, La., Norfolk, Va., and southern Texas.

Date begun.—1907.

Results.—The full life history of a newly introduced squash bug of economic interest nearly equal to the better-known species has been worked out, with control measures, and is now awaiting publication. Publications have already been issued on several of the more important cucumber beetles and the squash-vine borer (Farmers' Bulletin 668, Bureau of Entomology Circulars 31 and 59, and Bureau of Entomology Bulletin 82, Part IV), and tests leading to the completion of investigations on minor pests of cucurbitaceous plants have been carried out.

Assignment.—T. H. Jones, M. M. High, D. E. Fink.

Proposed expenditures, 1916-17.—\$1,000.

Sugar-Beet Insect Investigations:**(a) SUGAR-BEET LEAFHOPPERS—**

Object.—To obtain exact information regarding the life histories, alternate food plants, and means for the control of leafhoppers injurious to sugar beets, including the very destructive curly-top leafhopper, a pest which in some seasons totally destroys the sugar-beet crop in restricted localities and which is distributed over the entire Great Plains region and the Pacific coast.

Sugar-Beet Insect Investigations—Continued.

Procedure.—A comprehensive study is being made of the life history of the pest in its attacks on other plants and alternate wild host plants, of the effect of the attack on sugar beets, and of the best means for its control. The treatment of large acreages of sugar beets by means of sprays has proved ineffective, and a study of the wild host plants is necessary in order to promote control by clean culture. The effect on the plant is being studied both under laboratory and field conditions and through the silage of beets attacked the previous year, in order to ascertain the toxic effect of the leafhopper puncture on the flowering organism. A determination of the exact factors which have caused the regular outbreaks of this pest in widely separated localities throughout the Rocky Mountain region is being made in localities where the leafhopper is regularly present through the abundance of its natural food plants.

Cooperation.—Sugar-beet factories where stations are located.

Location.—Pasadena, Oxnard, and Spreckels, Cal., and Rocky Ford, Colo.

Date begun.—1909.

Results.—The sugar-beet leafhopper, which annually destroys from 50 to 90 per cent of the beet crop in widely separated localities, has been studied in Utah and Idaho and a preliminary report prepared for publication. Preliminary work is also being undertaken in California and Colorado.

Probable date of completion.—1918.

Assignment.—C. F. Stahl, H. O. Marsh, B. L. Boyden.

Proposed expenditures, 1916-17.—\$2,000.

(b) GENERAL SUGAR-BEET INSECTS—

Object.—To continue experiments in the control of the sugar-beet wireworm, and to conduct tests on the control of leaf beetles, flea beetles, false chinch bugs, aphides, webworms, white grubs, leaf miners, grasshoppers, and other insect enemies of sugar beets.

Procedure.—The usual methods of investigating the life histories and control of the pests mentioned are followed. The hibernation of many sugar-beet insects offers a vulnerable point of attack and has been the constant subject of experiment in the Rocky Mountain and Pacific regions, especially with regard to clean cultural methods and the removal from infested fields of refuse sugar beets in the case of the wireworms. Control by insecticides is also established. Life histories of many of these pests have been worked out, and observations are being conducted on others, in order to complete the project as early as possible.

Cooperation.—State stations in California.

Location.—Pasadena, Spreckels, and Oxnard, Cal., and Rocky Ford, Colo.

Date begun.—1908.

Results.—The sugar-beet webworm has been effectively controlled by the application of arsenical sprays. The beet-leaf beetle may be effectively destroyed during the winter by burning large bunches of panic grass which grow in waste places about beet fields and under which they hibernate. Control measures for the beet wireworms have been developed and demonstrated, as published in Bureau of Entomology Bulletin 123, and results are soon expected from work on the beet-root aphid. A report on the principal beet-feeding grasshoppers has been completed and published as Farmers' Bulletin 691. The life histories of many minor beet pests have been investigated.

Assignment.—H. O. Marsh, B. L. Boyden, C. F. Stahl.

Proposed expenditures, 1916-17.—\$3,000.

General Vegetable and Truck-Crop Insects:

Object.—To control the insect enemies of vegetable and truck crops not covered by specific projects, including garden vegetables, such as asparagus, beans, table beet, spinach, celery, parsnip, parsley, and related plants, eggplant, tomato, pepper, sweet potato, rhubarb, lettuce and other salad plants, salsify, okra, condiments, herbs, and medicinal plants; to test control methods commercially and in small plots, such as kitchen gardens; and to conduct similar work on mushroom insects. The list includes insects injurious to strawberry, raspberry, blackberry, and related small fruits. Among the most important insects which come under this head are the asparagus beetles and miner, the bean leaf-beetle, bean ladybird, leafhoppers, flea beetles, spinach aphid, loopers, stalk-borers, tarnished plant-bug, corn-ear worm or tomato-fruit worm, sweet potato root-borer, tortoise beetles and saw flies, rhubarb curculio, the strawberry weevil, leaf rollers, crown borers, and various other insects injurious to strawberry, blackberry, and related plants. As a part of this miscellaneous or

General Vegetable and Truck-Crop Insects—Continued.

unclassified work will be the handling of the natural enemies of insects attacking various crops, including ladybirds and parasites which control aphides or plant lice, parasitic enemies of the looper, and others. This line of work will be continued and the natural enemies introduced at new points where they can act as destroyers of host insects or pests.

Procedure.—This project will be carried on where possible in the District of Columbia and at near-by points in Maryland and Virginia, including a plat at the Arlington Farm, as well as in practically all of the stations of this branch of the bureau.

Cooperation.—Bureau of Plant Industry.

Location.—Washington, D. C., Norfolk, Va., and the experiment stations of this branch.

Date begun.—1907.

Results.—The life histories of many of these pests have been studied, investigations have been conducted on control measures, and many of the problems under this head are nearing completion. Practical work has been done on such insects as thrips, red spider, spinach aphid, and other plant-lice, including the nearly completed project on the introduction of ladybirds in tidewater Virginia, which has resulted in the suppression of the worst pests in that important trucking region. Preliminary work has been conducted on mushroom insects, and a new publication will soon be available to replace one which is practically exhausted.

Assignment.—F. H. Chittenden, C. H. Popenoe, T. H. Jones, W. H. White.

Proposed expenditures, 1916-17.—\$5,000.

Insects Attacking Greenhouse Vegetables:

Object.—To effect the control of several species of injurious insects affecting greenhouse truck crops as grown commercially in this country.

Procedure.—Methods adopted for the investigation of other injurious pests will be followed, including the study of the effects of fumigants and other insecticides in connection with various greenhouse temperatures and moisture conditions.

Location.—Washington, D. C.

Date begun.—1915.

Results.—Practical work has been accomplished on such insects as aphides or plant lice, white fly, greenhouse leaf-tyer, insects as transmitters of diseases in greenhouse plants, the various isopods and millipedes, slugs, and snails. This has of necessity been preliminary in character, since only for a year has a greenhouse for this purpose been available. It is planned to extend the facilities for this project in order that remedies for greenhouse truck-crop insects may be thoroughly studied under natural commercial conditions.

Assignment.—F. H. Chittenden, C. H. Popenoe, W. H. White.

Proposed expenditures, 1916-17.—\$2,500.

Total, Investigation of Truck-Crop Insects, \$32,000.

INVESTIGATIONS OF STORED-PRODUCT INSECTS.**Argentine Corn Weevil:**

Object.—To collect and determine in different localities the principal insects injurious to grain being shipped from tropical American countries; to determine the sources of damage and where the greatest amount may result under different conditions and seasons; to devise methods for preventing the losses from these sources to grain imported into the United States; and to minimize so far as possible the bad condition in which such grain is received.

Procedure.—The insects principally concerned are the rice or corn weevil of the South and the Angoumois grain moth. These have been studied from an economic standpoint in the climate of the District of Columbia, and practical studies have been made of grain as delivered from shipboard at various importing seaports. In order to determine the sources of attack, amount of loss, and other details, an expert should be sent to tropical America to ascertain these points, this information being necessary in the application of the best control measures.

Cooperation.—Bureau of Plant Industry and importers in New York City and elsewhere.

Results.—The investigation of the occurrence of the so-called Argentine corn weevil has not as yet been completed. A preliminary survey was made in 1915 at Baltimore and New York. Material for experiment leading to the pre-

Argentine Corn Weevil—Continued.

vention of losses, including the employment of fumigants at the source of infestation, is being gathered as opportunity permits, and practical control methods are being worked out. Necessarily the much lessened commerce in provisions from South American ports due to the European war has rendered it necessary to prolong the work on this project.

Probable date of completion.—1919.

Assignment.—F. H. Chittenden, A. B. Duckett.

Proposed expenditures, 1916-17.—\$1,000.

Insects Affecting Stored Beans and Peas:

Object.—To prevent the serious damage now experienced in the Southern States, in California, and in localities where beans, peas, and cowpeas are commercially grown, which naturally occurs through the ravages of the bean, pea, and cowpea weevils and related pests.

Procedure.—Assignment of experts is made to localities where bean and pea growing are important industries, and efforts are made by experiments in fumigation and other methods to ascertain the means of control for these important pests, the life histories being already quite thoroughly understood. In view of an unusual public demand for information on the subject, experiments will be conducted during the present fiscal year on the various methods of kiln-drying applicable to the treatment of beans of the Windsor, lima, and navy types, peas, and cowpeas for the prevention of continued injury to these food crops. Previous work on this project was conducted under "General Stored-Product Insect Pests."

Cooperation.—Growers.

Results.—The life histories of many of the important insects attacking leguminous seed have been worked out and preliminary experiments in regard to control measures made. It is desirable to give these further tests under actual storage conditions and in practical quantities. Treatment by kiln-drying appears to be entirely suitable for this work.

Probable date of completion.—1919.

Assignment.—F. H. Chittenden, C. H. Popenoe, A. B. Duckett.

Proposed expenditures, 1916-17.—\$2,000.

General Stored-Product Insect Pests:

Object.—To continue and complete studies which have already been made on the principal insects injurious to general stored products. About 60 species are concerned in this investigation, principal among which are the rice and granary weevils, the Angoumois grain moth, Mediterranean flour moth, Indian-meal moth, flour and grain beetles, the ham fly and ham beetles, various species of skin and carpet beetles, and many others, most of which are cosmopolitan. The lines of study may be grouped as follows: (1) Insects injurious to all forms of stored corn, wheat, rice, and other grain, including manufactured cereals, such as flour, meal, and breakfast foods. These will be studied with regard to their injury to grain stored in large and small bulk and in the package form where packed in this manner for convenience of consumers of cereals, as also in factories devoted to the manufacture or storage of such grains. (2) Insects injurious to dried fruits and nuts. (3) Insects injurious to animal products, such as cheese, dried meats, hides, leather, and woolen and other manufactured fabrics. (4) Insects injurious in seed warehouses and to herbs, drugs, and medicinal plants. Three insects previously unknown as pests have been injurious during the past few years and are being given appropriate study.

Procedure.—These insects are being studied from both the biological standpoint and with regard to natural enemies and natural and artificial means of control. Investigations of the life histories of these insects are nearly completed, and the principal experiments will be directed toward securing cheap and easily applied methods of control, such as heat and cold and fumigation under different conditions of building and in different portions of the country. Laboratories are established in the principal milling centers, wherein experiments may be undertaken on a practical scale, using commercial milling establishments for the tests.

Location.—Sacramento, Cal., Wichita, Kans., and Washington, D. C.

Date begun.—1908.

Results.—This subject has received constant attention for a number of years, during which time a great number of tests of standard and new fumigants, such as hydrocyanic-acid gas, bisulphid of carbon, and carbon tetrachlorid, have been made with respect to their applicability as insecticides and repellents.

General Stored-Product Insect Pests—Continued.

Experiments are nearly completed as to the availability of naphthaline for the protection of corn in cribs in the South and are promising excellent results. A campaign of education among millers has been conducted, with the result that mills are more free from grain-infesting insects at the present time than has been the case for years. The source of infestation of flour has been determined to be in most cases the mill, as infestation is unlikely to occur to any great extent on public conveyors or on board merchant vessels. Mechanical methods for the separation of beetles and their eggs from stored grains and flour promise much, but experiments must be completed before publication. A constant lookout has been kept for newly introduced pests, with the result that several foreign forms injurious abroad have been discovered to be already in the United States.

Assignment.—F. H. Chittenden, C. H. Popenoe, A. B. Duckett, R. E. Campbell, F. B. Milliken, M. M. High.

Proposed expenditures, 1916-17.—\$4,310.

Total, Investigations of Stored-Product Insects, \$7,310.

Total, Truck-Crop and Stored-Product Insect Investigations, \$46,620, including \$3,860 statutory.

BEE-CULTURE INVESTIGATIONS.**Supervision:**

Object.—To supervise the research and extension activities in connection with bee culture and to carry on administrative and clerical work necessary for their proper conduct.

Location.—Washington, D. C.

Date begun.—1881.

Assignment.—E. F. Phillips.

Proposed expenditures, 1916-17.—\$3,735 (research, \$2,935; extension, \$800).

[Research.]

Wintering of Bees:**(a) REACTION TO WINTER CHANGES—**

Object.—To determine the various methods by which bees respond to changes in external temperature and other environmental factors.

Procedure.—Careful records are kept of the temperature changes in the colony and hive in conjunction with records of climatic conditions surrounding them. The changes due to temperature have been studied, and meteorological and other environmental factors are now being taken up. The observations so far deal especially with temperature changes due to environmental factors.

Location.—Drummond, Md.

Date begun.—1912.

Results.—The reactions of the normal colony to changes in external temperature and the effects of various irritations have been determined and the results published in Department Bulletin 93. The effects of wind velocity and constancy and of changes in humidity of the air immediately surrounding the bees have been determined. A large mass of data has been obtained, which is being worked up as rapidly as possible for publication.

Probable date of completion.—1918.

Assignment.—E. F. Phillips, George S. Demuth.

Proposed expenditures, 1916-17.—\$3,500.

(b) CARE DURING WINTER—

Object.—To determine the best methods of caring for bees during winter in all sections of the United States. The purpose of this investigation is to determine the conditions under which bees do the least work in winter, thus conserving their vitality for spring activities.

Procedure.—From the records of activities of colonies in the cellar and of those packed and protected in various ways from adverse weather conditions out-of-doors the optimum environmental conditions are determined.

Location.—Drummond, Md.

Date begun.—1912.

Results.—A few of the practical phases have been discussed in Farmers' Bulletin 695, but the data now at hand when fully worked up will yield other definite practical results. Some of these details will be prepared for publication in the near future.

Wintering of Bees—Continued.

Probable date of completion.—1918.

Assignment.—E. F. Phillips, George S. Demuth.

Proposed expenditures, 1916-17.—\$3,000.

Development of Bees:

Object.—To investigate the morphology of the larva from the hatching of the egg to the beginning of pupation.

Procedure.—Normal larvæ are prepared and microscopically studied. Some details of physiology are also investigated, especially those which have to do with beekeeping practice.

Location.—Drummond, Md.

Date begun.—1913.

Results.—This is a continuation of the investigation of the development of the bee in the egg, the results of which have recently been published in book form. The work on the development of the larva is still under way.

Probable date of completion.—1918.

Assignment.—James A. Nelson.

Proposed expenditures, 1916-17.—\$2,500.

(**Sense Organs of Bees:** This project has been completed and the results published in the American Bee Journal and other technical journals.)

Effects on Bees of Spraying Fruit Trees:

Object.—To determine whether bees are killed by spraying fruit trees for codling-moth control; and, if so, through what means and under what conditions.

Procedure.—Observations of colonies of bees will be made in or near sprayed orchards.

Location.—Various bureau field stations.

Date begun.—1914.

Results.—In 1914 orchards were purposely sprayed in full bloom to determine how bees are killed by arsenicals. In 1915 and 1916 observations were made under conditions of commercial spraying. Final results have not yet been obtained.

Probable date of completion.—1917.

Assignment.—George S. Demuth.

Proposed expenditures, 1916-17.—\$500.

Diseases of Bees:**(a) ETIOLOGY OF BEE DISEASES—**

Object.—To determine the causes of the diseases of bees.

Procedure.—Bacteriological examinations are made of diseased material and inoculation of healthy colonies made with various microorganisms.

Location.—Washington, D. C.

Date begun.—1907.

Probable date of completion.—September, 1916.

Assignment.—G. F. White.

Proposed expenditures, 1916-17.—\$625.

(b) DISTRIBUTION AND CONTROL OF BEE DISEASES—

Object.—To learn where the various bee diseases are now located and to devise means of treatment and control.

Procedure.—Suspected material from various localities is examined. Cooperation is maintained with beekeepers in the improvement of apiary inspection. Experiments are under way on the treatment of diseased colonies.

Location.—Drummond, Md.

Date begun.—1907.

Results.—The distribution of American foul brood and European foul brood is known and results will soon be published. Apiary inspection has been greatly increased through the activities of the office.

Probable date of completion.—1918.

Assignment.—A. H. McCray.

Proposed expenditures, 1916-17.—\$2,200.

(**Wax Production:** Project discontinued. Only preliminary experiments have been made so far, on account of lack of time and funds. It is possible that the work may be taken up again at some later time.)

[Extension.]

Demonstration Work in Beekeeping:

Object.—To conduct demonstrations and to provide instructions in beekeeping through and in cooperation with the county agricultural agents in the Southern States.

Procedure.—A specialist in beekeeping will be appointed in cooperation with the Office of Extension Work in the South, States Relations Service, and two specialists will be appointed in two Southern States, (to be selected). These men will cooperate with the county agents in carrying to beekeepers in the South the best methods of beekeeping.

Cooperation.—Through States Relations Service, with extension divisions of State agricultural colleges.

Location.—Southern States (exact location to be selected).

Date begun.—July 1, 1916.

Assignment.—Assistant to be appointed.

Proposed expenditures, 1916-17.—\$5,500.

Total, Bee-Culture Investigations, \$21,560, including \$1,560 statutory (research, \$15,260; extension, \$6,300).

[Research.]

TROPICAL AND SUBTROPICAL FRUIT INSECT INVESTIGATIONS.**Supervision:**

Object.—General administration and direction of investigations and routine laboratory and clerical work.

Location.—Washington, D. C.

Date begun.—1907.

Assignment.—C. L. Marlatt.

Proposed expenditures, 1916-17.—\$5,000.

Citrus-Fruit Insect Investigations in California:

Object.—To investigate the injurious insects of subtropical fruits of southern California, particularly the orange, including such continuation as may be necessary of experimental work in the fumigation of citrus groves with hydrocyanic-acid gas; study of other means of control of citrus insects, and means of control of insects affecting the olive, guava, and other subtropical cultures; and study of the life history and habits of all of these insects as a basis for control operations.

Procedure.—Direct experimental control operations in cooperation with grove owners, and field and laboratory studies of the insects involved; special studies of insecticides and other means of control.

Cooperation.—County horticultural commissioners and Bureau of Chemistry.

Location.—Headquarters, Pasadena, Cal.; citrus belts of southern California.

Date begun.—1907.

Results.—(1) During 1916: Experimental work with hydrocyanic-acid gas carried on; preparation of new manuscript for bulletin on fumigation, including the results reported in Bureau of Entomology Bulletins 79 and 90, and bringing information to date as a concluding report on this phase of the subject; conduct of a series of orchard tests with various means of controlling the citrus mealy bug, an insect not controlled by fumigation; demonstration of the possibility of successful control, results to be shortly available for publication; and incidental work on other tropical and subtropical insects affecting such cultures in southern California.

Prior to 1916: Standardization of the hydrocyanic-acid gas treatment of citrus trees in orchards; fumigation placed on an accurate scientific basis, greatly increasing its efficiency; the revised methods now generally practiced.

Probable date of completion.—July 1, 1919.

Assignment.—R. S. Woglum.

Proposed expenditures, 1916-17.—\$6,000.

Citrus-Fruit Insect Investigations in Florida:

Object.—To test on a commercial basis the practicability of control measures for the white fly and scale insects, recommended as the result of investigations of previous years; also to investigate the biology, injury, and methods of control of the rust mite and any new and injurious insects affecting citrus trees in Florida.

Citrus-Fruit Insect Investigations in Florida—Continued.

Procedure.—Suitable groves in various sections of the State are selected and sprayed in accordance with methods which early experimental work has shown to be most promising. Life-history studies and methods of control are investigated in the laboratory and in the field. Incidentally other insects affecting tropical and subtropical fruit trees are given consideration.

Cooperation.—Florida Experiment Station and local grove owners.

Location.—Headquarters, Orlando, Fla., with experimental demonstrations practically throughout the State.

Date begun.—1907.

Results.—(1) During 1916: Further demonstration of the practicability of control of the citrus white fly, at nominal cost, by the use of sprays recommended; demonstration of sulphur control of the rust mite, correcting the injuries from this pest known as "russety fruit," "shark skin," "silver scurf," and "buckskin"; demonstration of these results in some twenty orchards treated in cooperation with and, except for supervision, at the expense of owners.

Prior to 1916: Satisfactory methods of control of the white fly perfected, the life history of the insect determined, and predacious and parasitic insects studied. Results reported in the following publications of the Bureau of Entomology: Bulletin 76, "Fumigation for the Citrus White Fly"; Circular 168, "Spraying for White Flies in Florida"; Bulletin 102, "Natural Control of White Flies in Florida"; Circular 111, "Preparations for Winter Fumigation for the Citrus White Fly"; Bulletin 92, "White Flies Injurious to Citrus in Florida"; also in Journal of Agricultural Research, vol. 2, No. 6, "Papaya Fruit Fly"; and Economic Entomology, vol. 8, No. 2, "Spraying Scheme for the Control of Insect Pests on Citrus Trees in Florida."

Probable date of completion.—July 1, 1919.

Assignment.—W. W. Yothers.

Proposed expenditures, 1916-17.—\$4,000.

(Citrus-Fruit Insect Investigations in Louisiana: This investigation, which has been going on for something over two years, has been suspended on account of the hurricane of the fall of 1915, which so injured the experimental orchards and eliminated the fruit as to make the further continuation of work at this time impracticable. It is proposed at an early date to take up this work again. In the meantime, the main feature of this work is being completed in southern California in relation to the Argentine ant, and a bulletin giving the results so far obtained will shortly be available for publication. The appropriation for this work has been applied to a new but related project, entitled "Investigation of the Argentine Ant in Relation to Citrus Fruits." This project will permit the investigation of this ant over a larger field, including both the Gulf region of Louisiana and Texas and also southern California, where this insect has become firmly and widely established.)

Investigation of the Argentine Ant in Relation to Citrus Fruits:

Object.—The Argentine ant is believed to have a very important injurious effect in relation to citrus orchards, by direct injuries due to it and also largely because it is believed to harbor and colonize on the trees various scale-insect and plant-lice enemies of citrus fruits. The investigation of the Argentine ant in relation to citrus trees, which was begun under the project "Citrus-Fruit Insect Investigations in Louisiana," is being continued under this new title to limit the work specifically to the Argentine ant and indicate the wider geographic range of the investigation. The Argentine ant now occurs abundantly in southern California and is there being considered as a very important citrus pest. This project, therefore, is supplemental to the suspended Louisiana citrus-fruit insect investigations.

Procedure.—Cooperative work in connection with grove owners, taking up the subject for southern California very much as it was taken up in Louisiana, to furnish a check on Louisiana results and to develop any differences which may arise from the rather wide variation in climatic conditions between southern California and the Gulf district of Louisiana.

Cooperation.—Local grove owners.

Location.—Pasadena, Cal.

Date begun.—1916.

Probable date of completion.—1917.

Assignment.—J. R. Horton.

Proposed expenditures, 1916-17.—\$3,000.

Investigations of Insects Affecting Tropical and Subtropical Fruits and Plants in Greenhouses:

Object.—To perfect economical and effective commercial methods of controlling insects affecting tropical and subtropical fruits and plants in greenhouses. Life-history studies will be undertaken when necessary.

Procedure.—Suitable greenhouses are to be selected for testing the principal means of control, namely, fumigation, and arsenicals and other sprays.

Cooperation.—Federal Horticultural Board, Bureau of Plant Industry, and Bureau of Chemistry.

Location.—Washington, D. C.

Date begun.—1915.

Results.—A very important line of experimental work has been conducted during the past year which will eventually result in the full standardizing of greenhouse treatment to control insect pests. Greenhouse fumigation, particularly, has been standardized in relation to the proper dosage for different kinds of plants and the strength necessary for the control of the different greenhouse insect pests. Various insecticides have also been tested to determine their effect on the common insects infesting greenhouse plants. Most of this work has been conducted in a special experimental greenhouse assigned for the purpose, but more or less of it has been done in cooperation with local growers of plants under glass.

Probable date of completion.—July 1, 1919.

Assignment.—E. R. Sasser, for the Federal Horticultural Board, and A. D. Borden.

Proposed expenditures, 1916-17.—\$2,500.

Investigations of Miscellaneous Tropical and Subtropical Fruit Insects:

Object.—To investigate unusual outbreaks of injurious insects affecting tropical and subtropical fruits not included in the preceding projects.

Procedure.—This work is directed from Washington, D. C., and consists mainly in correspondence and in investigations of unusual outbreaks of insects affecting subtropical fruits. Incidentally other insects affecting tropical and subtropical fruit trees will be given consideration.

Location.—Work directed from Washington, D. C.

Date begun.—1913.

Results.—The allotment for this work is used as a reserve fund. During the past year the allotment was turned over to other investigations, in view of the fact that there was no occasion for its use in controlling unusual outbreaks of insects affecting citrus trees.

Probable date of completion.—July 1, 1919.

Assignment.—Special assignment as needed.

Proposed expenditures, 1916-17.—\$1,000.

Total, Tropical and Subtropical Fruit Insect Investigations, \$21,500, including \$4,400 statutory.

INVESTIGATION AND CONTROL OF THE MEDITERRANEAN AND OTHER FRUIT FLIES.

Supervision:

Object.—General control and direction of the various projects and the conduct of the administrative office, in cooperation with the Federal Horticultural Board.

Location.—Washington, D. C.

Date begun.—1912.

Assignment.—C. L. Marlatt.

Proposed expenditures, 1916-17.—\$5,000 (research, \$2,000; regulation, \$3,000).

[Regulation.]

Control of Export Hawaiian Fruit:

Object.—The general enforcement of Quarantine No. 13 on account of the Mediterranean fruit fly and the melon fly, including inspection and certification of pineapples and bananas for export from Hawaii to the mainland of the United States.

Procedure.—Enforcement of the prohibitory features of the quarantine by inspection of exports from Hawaii and by warnings and notifications to common carriers and their agents and to shippers and all passengers on vessels plying between Hawaii and the United States, supplemented by further inspection at

Control of Export Hawaiian Fruit—Continued.

mainland ports of arrival, in cooperation with the State horticultural authorities; inspection and certification of Hawaiian pineapples and bananas offered for export to the United States.

Cooperation.—Federal Horticultural Board, Hawaiian Territorial Board of Agriculture, State inspectors, and United States postal service and customs service.

Location.—Honolulu, Hawaii, San Francisco, Cal., and other Pacific ports.

Date begun.—1912.

Results.—Effective enforcement of the regulations governing the movement of pineapples and bananas; enforcement of the prohibition of the movement to the mainland of other host fruits of the Mediterranean fruit fly and the melon fly.

Assignment.—C. E. Pemberton.

Proposed expenditures, 1916-17.—\$10,000.

Control of Foreign Fruit Offered for Entry:

Object.—Inspection and regulation of the entry of fruit imported into the United States from Mediterranean and other countries in which the fruit flies are known to occur.

Procedure.—Fruits likely to be infested with the fruit flies are inspected at various ports of entry.

Cooperation.—Federal Horticultural Board, United States postal service and customs service, State inspectors, and inspection services of foreign countries.

Location.—Washington, D. C., and ports of entry.

Date begun.—1912.

Results.—Efficient inspection being maintained at ports of entry where importations of dangerous fruit flies may be expected, notably Pacific ports; a prohibitory quarantine maintained against citrus fruit of Mexican origin.

Assignment.—C. L. Marlatt.

Proposed expenditures, 1916-17.—\$5,000.

[Research.]**Investigations of Foreign Fruit Offered for Entry:**

Object.—Investigations of fruits imported into the United States from Mediterranean or other countries in which fruit flies are known to occur, as a basis for any necessary quarantine action.

Procedure.—Inspection at port of entry or at destination of fruit imported from foreign countries in which the fruit flies are known to occur.

Cooperation.—Federal Horticultural Board.

Location.—Washington, D. C., and various ports of entry.

Date begun.—1912.

Results.—Results of importance for action of Federal Horticultural Board obtained relative to the lemon and other citrus fruits from Mediterranean countries, and tomatoes, potatoes, figs, and other fruits from the same region, and fruits likely to be imported from Bermuda and the West Indies; similar results obtained relative to Mexican fruits and fruits of trans-Pacific origin. This investigation is a continuing one and must be kept up each year covering substantially the same ground.

Assignment.—C. L. Marlatt.

Proposed expenditures, 1916-17.—\$5,700.

(Life-History Studies of the Fruit Fly: Discontinued as a separate project; included under "Geographical Distribution and Life-History Studies of Fruit Flies.")

Geographical Distribution and Life-History Studies of Fruit Flies:

Object.—To determine the geographical distribution and importance of fruit-fly enemies of imported fruits as a basis for needed quarantine or regulatory action, including studies of life history, means of artificial control, and control through introduction and distribution of natural enemies.

Procedure.—Surveys of districts from which the United States receives imported fruit in relation to known fruit-fly enemies which it is desirable to exclude from this country; study of these insects to determine their habits and means of exclusion with the least restriction to fruit importations; study of means of control and natural control agencies.

Cooperation.—Federal Horticultural Board, Hawaiian Territorial Board of Agriculture, and proper officials and experts of foreign countries concerned.

Geographical Distribution and Life-History Studies of Fruit Flies—Cont'd.

Location.—Headquarters, Washington, D. C.

Date begun.—1916, as a separate project; continued from project "Life-History Studies of the Fruit Fly," begun in 1912.

Results.—Life history, food habit, and control features of the Mediterranean fruit fly fairly thoroughly worked out and a general report now available for printing covering the whole subject. Preliminary articles were published in the Journal of Agricultural Research as follows: "Papaya Fruit Fly," vol. 2, No. 6; "Life History of the Melon Fly," vol. 3, No. 3; "Susceptibility of Citrus Fruits to the Attack of the Mediterranean Fruit Fly," vol. 3, No. 4; "Life History of the Mediterranean Fruit Fly from the Standpoint of Parasite Introduction," vol. 3, No. 4; "Banana as a Host Fruit of the Mediterranean Fruit Fly," vol. 5, No. 17; "Effect of Cold-Storage Temperatures upon the Pupæ of the Mediterranean Fruit Fly," vol. 6, No. 7; and "Effect of Cold-Storage Temperatures upon the Mediterranean Fruit Fly," vol. 5, No. 15.

Assignment.—E. A. Back.

Proposed expenditures, 1916-17.—\$7,500.

Total, Investigation and Control of the Mediterranean and Other Fruit Flies, \$33,200 (research, \$15,200; regulation, \$18,000).

[Research.]

MISCELLANEOUS INSECT INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To supervise the investigations and carry on administrative and clerical work necessary for their practical conduct.

Location.—Washington, D. C.

Date begun.—1879.

Assignment.—L. O. Howard, W. D. Hunter.

Proposed expenditures, 1916-17.—\$1,405.

IDENTIFICATION AND CLASSIFICATION OF INSECTS.**Identification and Classification of Insects:**

Object.—Identification and classification of insects, including anatomical and biological work of a general character. The work under this project forms the basis for many of the investigations of the bureau. It supplies the fundamental information necessary before field investigations can be prosecuted. It also provides a reference section for the comparison of specimens and aids State entomologists and others in the general promotion of entomology and the control of injurious species.

Procedure.—Competent specialists are placed in charge of the collections at the U. S. National Museum, who determine all material which is sent in. Practically every year some unexpected and unusual outbreak occurs, frequently of some insect which has not been carefully studied, making it necessary to conduct immediate field investigations. Such funds as are needed for this emergency investigation are as a rule drawn from this allotment, and the special experts of the identification-work assignment are used in such cases so far as possible.

Cooperation.—National Museum, which houses the collections and provides working rooms.

Location.—Washington, D. C.

Date begun.—1897.

Results.—Used in correspondence, in publications of the bureau, and by employees engaged in biological studies in the field.

Assignment.—Nathan Banks, A. N. Caudell, H. G. Dyar, Otto Heidemann, Frederick Knab, E. A. Schwarz, Rolla P. Currie.

Proposed expenditures, 1916-17.—\$29,765, including \$6,440 statutory.

INVESTIGATIONS OF INSECTS AFFECTING THE HEALTH OF MAN.**Eradication of Spotted-Fever Tick in Montana:**

Object.—To reduce or eradicate the spotted-fever tick in the Bitter Root Valley of Montana by control of the tick which transmits it.

Eradication of Spotted-Fever Tick in Montana—Continued.

Procedure.—Systematic weekly dipping of all large domestic animals in the lower half of the Bitter Root Valley will be carried on during the months when the adult ticks are present on hosts. Careful observations will be made while this work is in progress to ascertain the best conditions for dipping and all possible modifications of the methods that may be more efficient. Careful biological studies of the ticks are made and also seasonal studies. Educational work is carried on incidentally to enlighten the farmers regarding the dangers of the tick and the best methods of getting rid of it. Experiments with spring and fall burning over of pastures are made to test the effect on tick destruction and ultimate control. The killing of ground squirrels and other rodents that act as hosts for the immature stages of the tick is encouraged.

Cooperation.—Montana State Board of Entomology, State entomologist of Montana, State Board of Health of Montana, United States Public Health Service, and Bureau of Biological Survey.

Location.—Bitter Root Valley, Montana.

Date begun.—1913.

Results.—Considerable progress has been made in the extermination of the ticks, and the work has been received very favorably by the people in the Bitter Root Valley.

Assignment.—W. V. King, W. D. Hunter.

Proposed expenditures, 1916-17.—\$8,300.

Relation of Malaria Mosquitoes to Agriculture:

Object.—To prevent malaria on the farm, with special reference to the requirements of southern plantations; and to determine the measures of prevention that apply in a practical manner to farming conditions, based on methods for the protection from or the repression of the mosquitoes which convey the disease.

Procedure.—An intensive study is being made on a plantation in the delta region of Louisiana in the lower Mississippi Valley, where conditions are typical as regards plantation operations, endemic malaria, and the mosquitoes that convey the disease. Comparative studies are in progress in southern Arkansas and in the Yazoo-Mississippi delta and the hill country of Mississippi. The work includes a determination of the manner in which malaria reduces the net profits from crops; the bionomics of the species of mosquitoes that convey the disease; the relation of the malaria blood parasites to their mosquito hosts, to determine the species of mosquitoes concerned in the transmission of the disease, the conditions of the survival of the malaria organisms in the mosquito, and the comparative efficiency of the various mosquito hosts as vectors of the disease under known environmental conditions; and experimental measures of control, to determine those methods that can be coordinated with the operations of a plantation on a practical basis.

Cooperation.—Maxwell-Yerger Co., Mound, La., Tulane Medical School, New Orleans, La., Mississippi Agricultural College, Agricultural College, Miss., Bureau of Fisheries, and Office of Farm Management.

Location.—Mound, La., Scott, Ark., New Orleans, La., and points in Mississippi.

Date begun.—1913.

Results.—The amount of the reduction in crops on one plantation from loss of time and reduced efficiency of labor on account of malaria has been measured. The species of mosquitoes involved in the transmission of the disease in this particular region have been determined, and progress has been made in the study of their breeding requirements. The relation of rainfall and temperature to mosquito density and of mosquito density to the malaria rate is under consideration. A study of the longevity of the malaria organisms in the body of the mosquito hosts and the comparative efficiency of the various species of malaria mosquitoes to act as vectors of the disease is in progress. One species, heretofore generally considered as a nonconveyor of the disease, has been definitely incriminated as an efficient host. Experimental control measures, including favorable locations for houses in respect to mosquito infestation, treatment of surface collections of water to render them unsuitable for mosquito breeding, destruction of adult mosquitoes, mechanical protection from adult mosquitoes, drainage, and the use of fish that feed upon mosquitoes, are in progress.

Assignment.—D. L. Van Dine, W. V. King.

Proposed expenditures, 1916-17.—\$7,000.

House-Fly Control:

Object.—To study the habits of the house fly with reference to control, and to test agents for use in destroying the immature stages in stable manure and in other substances.

Procedure.—Experiments are conducted at various places to throw light on points in the life history of the fly on which little or no information is available at this time. Special attention will be given to the testing of baits for use in connection with fly traps of various kinds, and the reactions of the fly to various repellents will also be studied. A recent suggestion for the use of poison baits which are sprayed about stables will be tested through experiments conducted under varying conditions. The effectiveness of various types of pits or bins for destroying the insects in stable manure will receive attention, and an effort will be made to adapt a recent discovery about utilizing the natural heat of fermenting manure to prevent the development of flies. Further studies of the maggot trap, which has been brought to a reasonable perfection as a result of the work of the project, will be conducted, and studies will be made of the parasitic enemies of the house fly.

Cooperation.—Bureaus of Chemistry, Plant Industry, and Animal Industry, and the Maryland Agricultural College.

Location.—Drummond, Bethesda, and College Park, Md.

Date begun.—1913.

Results.—In the recent work on the house fly all chemicals which have been suggested for use in destroying the immature stages have been tested and their relative efficiency determined. Two substances which have not heretofore been used for this purpose have been found to be very effective, and their use has already become general through the publications of the department. The maggot trap offers a means of removing fly larvæ from stable manure without the application of any chemicals.

Assignment.—R. H. Hutchison.

Proposed expenditures, 1916-17.—\$2,700.

Control of the House Fly and Other Insects in Establishments Operating under Federal Meat Inspection:

Object.—To devise plans for the control and eradication of the house fly and other insects under the special conditions existing in establishments operating under Federal meat inspection.

Procedure.—Various meat-packing establishments are visited in different parts of the country for the purpose of obtaining information on the species of flies giving annoyance, to determine their breeding places under the different conditions presented, and to suggest to the inspectors in charge methods of improving the situation. At Dallas and Fort Worth, Tex., more special investigations are conducted. These consist in the testing of different types of traps and baits and of methods of eliminating breeding places or destroying the infestations by means of chemicals and a study of the most desirable procedure in handling various packing-house waste products, such as paunch manure and contaminated water from washing floors, and of possible methods of checking fly breeding in stock yards, sales stables, and other prolific fly-breeding places in the vicinity of packing plants. The life histories and habits of the various species concerned are studied, in order to determine the most vulnerable points of attack. Experiments are also under way to determine the most effective screens for use in eliminating the several species of insects from slaughtering and packing establishments.

Cooperation.—Bureau of Animal Industry and establishments operating under Federal meat inspection.

Location.—Dallas and Fort Worth, Tex., and various cities where establishments are operated under Federal inspection.

Date begun.—1915.

Results.—During the fiscal year 1916 a very efficient and cheap type of flytrap was devised and certain fly baits were found which are much more effective than various others generally used. These findings have been placed in the hands of the inspectors in charge at all of the stations in the United States. A farmers' bulletin dealing with the question of flytraps and their operation, which will be useful to city sanitarians, dairymen, and farmers, as well as to butchers and packers, has been prepared.

Assignment.—F. C. Bishopp and E. W. Laake, of the Bureau of Entomology, and George H. Shaw, of the Bureau of Animal Industry.

Proposed expenditures, 1916-17.—\$2,500.

Total, Investigations of Insects Affecting the Health of Man, \$20,500.

INVESTIGATIONS OF INSECTS AFFECTING THE HEALTH OF ANIMALS.

Life-History Investigations of the Cattle-Fever Tick:

Object.—To obtain accurate information regarding the life history and habits of the tick which will be of value in the work of eradication now under way in the Southern States, and also to aid in the control of the pest in regions where the general plan of eradication is not at present applicable.

Procedure.—The host relations, distribution, and longevity of the tick in its various stages are being studied. In this work a number of experimental animals are used to determine host relations and length of development periods. The possibility of various animals and birds scattering the ticks is studied under lot and pasture conditions. The effect of climatic conditions on the different stages is studied by exposing ticks in nature and by observation on them in refrigerators and incubators.

Cooperation.—Tennessee and Louisiana experiment stations, Bureau of Animal Industry, and individual cattle owners in the State of Texas.

Location.—Dallas, Victoria, and Uvalde, Tex.

Date begun.—1904.

Results.—Information has been gained which will assist in the work of eradication by dipping. An efficient system of tick destruction by means of pasture rotation has also been devised.

Probable date of completion.—1918.

Assignment.—F. C. Bishopp.

Proposed expenditures, 1916-17.—\$4,100.

Investigations of Ticks Other than Cattle Ticks and Spotted-Fever Tick:

Object.—To determine the relation of these pests to various hosts, the biology of the species, and feasible means of controlling them.

Procedure.—This project is divided into the following activities: Investigations of (1) the fowl tick, (2) the spinose ear tick, (3) the Lone Star tick, (4) the winter tick, (5) the Gulf coast tick, and (6) other species. The life histories, habits, host relation, and seasonal histories of each species are being worked out. In this work various host animals are infested and the development of the ticks noted, the length of the various developmental periods when not on hosts determined, and the period necessary to destroy by starvation obtained. The effect of various tickicides on different species is tested. Methods by which these injurious species are likely to be spread are also being studied.

Cooperation.—Cooperation has been arranged with the Bureau of Animal Industry to investigate the possible occurrence of Spirochetosis of fowls in the United States and to determine the effect upon the health of the host of killing mixtures found to be favorable tickicides.

Location.—Dallas, Victoria, and Uvalde, Tex., and Bitter Root Valley, Mont.

Date begun.—1905.

Results.—During 1916 biological observations have been continued on several species. Prior to 1916 the life histories of several ticks were quite completely investigated and extensive bulletins published. Effective control measures against the fowl tick have been devised and given to the public.

Assignment.—F. C. Bishopp.

Proposed expenditures, 1916-17.—\$1,500.

Stable Fly:

Object.—To determine feasible methods of control by artificial and natural means of this cosmopolitan pest of animals and man.

Procedure.—Based upon studies of the biology and habits of this pest, investigations of methods of eliminating breeding places are to be continued. These include improved methods of disposing of straw, especially in the grain belt, either by careful stacking or by prompt spreading and turning under. Special attention will be given to severe local outbreaks, and further studies of methods of protecting horses and other live stock from attack by protective coverings and repellents will be continued. Observations will be continued in localities where infectious anemia of horses occurs, in order to gain further information regarding the possible relationship of this fly to the disease. The distribution and seasonal occurrence of this fly are studied, with a view to determine its possible relationship to diseases of man. Investigations of the utilization of parasites in practical control where already established and their introduction into regions where they do not occur will be undertaken.

Stable Fly—Continued.

Cooperation.—Cooperation is arranged with the Bureau of Animal Industry to determine the extent to which Texas fever becomes acute as a result of the attack of this fly, and also, if possible, to determine the relationship of the insect to infectious anemia. Cooperation has also been obtained with the Hawaiian Experiment Station by breeding and shipping parasites to that station.

Location.—Dallas, Tex., and Aberdeen, S. Dak.

Date begun.—1912.

Results.—Prior to 1916 investigations were made which showed the importance of this pest from the stock raiser's standpoint, and as a result of biological studies certain recommendations which have resulted in the avoidance of outbreaks were made. The work of the season dealt largely with practical tests of control measures.

Assignment.—F. C. Bishopp, W. E. Dove.

Proposed expenditures, 1916-17.—\$500.

Screw Worms:

Object.—To determine the various species of flies which attack animals and man, causing various types of myiasis, and the conditions favoring such infestation; to determine the life histories, seasonal activity, and habits of these flies, and to test methods of control.

Procedure.—Larvæ from infested animals and man are collected and reared and the character and conditions prior to infestation studied. Experiments are conducted to determine the effect of the burial of carcasses at different depths, their treatment with chemicals, and their destruction by burning, on the production of screw-worm flies, which breed in great numbers in dead animals. Tests are made of the relative effectiveness of different repellents on various species of screw-worm flies, and in other tests are employed attractive substances to be utilized as possible poisoned baits.

Cooperation.—The Bureau of Animal Industry will cooperate in experiments in the destruction of the larvæ in living animals, and various physicians will furnish specimens of screw worms.

Location.—Dallas, Uvalde, and Victoria, Tex.

Date begun.—1914.

Results.—In 1916 it was determined that by so breeding range stock as to have the calves drop in the winter or very early spring considerable reduction of losses through the infestation of calves could be secured. One obstacle to this work has been the absence of suitable pastures in many districts of the Southwest. The biologies of several of the species which have been found to attack living animals have been determined. It has also been found that a common black blowfly not heretofore known to be injurious is the cause of maggoty wool among sheep in the Southwest. Information on this subject was published in the Journal of Economic Entomology, vol. 8, No. 5. Prior to 1916 only preliminary observations had been made.

Assignment.—F. C. Bishopp.

Proposed expenditures, 1916-17.—\$1,750.

Horseflies:

Object.—To determine feasible means of controlling the various species of horseflies and thus reduce the annoyance to man and animals and the dangers of spreading anthrax among animals and to man. By devising methods of combating the horseflies in the southern portions of Louisiana and Texas it is thought that certain extensive areas will be developed into excellent cattle-producing regions.

Procedure.—Investigations of the species which are playing important rôles in the transmission of disease and in worrying animals will be conducted in regions where the losses are most acute, notably portions of southeast and southwest Texas, southern Louisiana, and certain valleys in Nevada and California. The biologies of various species of this group of flies are quite different and each requires separate investigations. Based upon these studies, it is hoped to develop practical methods of control. It is necessary to consider methods of irrigation and drainage in connection with the question of repression.

Cooperation.—Nevada Experiment Station, Nevada Land and Cattle Co., Bureau of Animal Industry, and Texas State Board of Health.

Location.—Dallas, Uvalde, and Beaumont, Tex., Avery Island and Lake Charles, La., Topaz, Cal., and Reno and Deeth, Nev.

Date begun.—1914.

Horseflies—Continued.

Results.—In 1916 the biology of the species which is of much importance in southwest Texas was partially worked out and methods of increasing the efficiency of natural enemies devised. The principal species of horseflies causing losses in certain parts of the country were determined. Prior to 1916 only preliminary work had been done.

Probable date of completion.—1925.

Assignment.—F. C. Bishopp, D. C. Parman.

Proposed expenditures, 1916-17.—\$3,000.

Horn Fly:

Object.—To devise and improve methods of horn-fly control.

Procedure.—The life history and habits are being studied, particular attention being given to an investigation of the longevity of adults and method of hibernation. Studies are made of the value of the systematic collecting and spreading of manure on fields at dairies. Tests are under way to determine whether the systematic destruction of adult flies on dairy herds by means of sprays is practicable. Experiments are being made in the utilization of manure-inhabiting insects which either destroy the immature flies directly or cause the drying out of the manure and their destruction thereby.

Cooperation.—Cooperative arrangements have been made with the Porto Rico Experiment Station by which certain insects, found useful in controlling the horn fly in the United States, are shipped to Porto Rico, where the horn fly has recently been introduced.

Location.—Dallas and Victoria, Tex.

Date begun.—1914.

Results.—No important results during 1916. Prior to this the spread of the flies in this country and certain methods of control were reported upon. The latter included the announcement of the plan of placing splash boards along the sides of vats used in dipping cattle in the South. This method accomplished the destruction of a large percentage of the adult flies on the live stock.

Probable date of completion.—1920.

Assignment.—F. C. Bishopp, J. D. Mitchell, H. P. Wood.

Proposed expenditures, 1916-17.—\$500.

Ox Warbles:

Object.—To determine the present status of ox warbles in the United States and to investigate the life histories, habits, and seasonal histories of these species, together with improved methods of control.

Procedure.—The biology of the common ox warble of this country is to be studied on experimental animals kept under control, and field observations will be made on the abundance and seasonal history of the two species by various agents of the bureau, as well as by correspondents throughout the country. Through correspondence specimens are obtained from different parts of the United States to determine the distribution and relative abundance of the warbles in this country. One of the principal control measures, namely, the extraction of warbles by hand, is being tested on a number of dairy herds. The effect of arsenical dip on various stages of ox warbles is to be studied.

Cooperation.—The Bureau of Animal Industry will consider the question of possible injury to animals by penetration of the dip through holes in the hides made by the ox warbles and, as a result of the destruction of the grubs beneath the skin, the effect on the hosts of frequent dippings during the season when the eggs are laid. That bureau will also supply specimens obtained by inspectors at various packing houses.

Location.—Dallas, Uvalde, and Victoria, Tex.

Date begun.—1914.

Results.—During 1916 it was determined that the European ox warble, formerly supposed not to exist in this country to any extent, is rather widely distributed throughout the Northern States and is a pest of importance in the northwestern portion of this country. Considerable information has been gained regarding the abundance of this pest in different regions.

Assignment.—F. C. Bishopp.

Proposed expenditures, 1916-17.—\$400.

Chicken Flea:

Object.—To accumulate information on the life history, habits, distribution, and injuriousness of the insect and how it may be controlled.

Procedure.—The life-history work will be conducted in cage experiments, using chickens, dogs, and rabbits as hosts. Various methods of treating the chicken yards and also the animals will be studied.

Location.—Dallas, Tex.

Date begun.—1914.

Results.—During 1916 feasible methods of reducing the number of chicken fleas in poultry were determined. Two publications of the department dealing in part with this pest have been issued, namely, Department Bulletin 248 and Farmers' Bulletin 683.

Probable date of completion.—1920.

Assignment.—F. C. Bishopp, H. P. Wood.

Proposed expenditures, 1916-17.—\$200.

Miscellaneous Insects Affecting Live Stock:

Object.—To devise means of control of various insect pests affecting live stock, including bot flies of horses, buffalo gnats, the chicken bug of the Southwest, chicken mites, and other animal and poultry insects.

Procedure.—Accumulation of information on various animal parasites will be made incidental to other work. The bot flies of horses and chicken mites and lice will receive special attention at this time. For the most part, other more extended investigations will be undertaken when outbreaks of importance occur. In the case of the horse bots the so-called nose fly, which is causing serious annoyance to farmers in the North-Central States, is to be investigated by an agent stationed in South Dakota. This work will include incidental studies of the other two species of horse bots in the Dakotas and Texas.

Location.—Dallas, Tex., Aberdeen, S. Dak., and various field laboratories of the bureau.

Date begun.—1912.

Results.—During the fiscal year 1916 the biology of the nose fly was quite thoroughly worked out. The bionomics of the chicken mite were given considerable attention and improved methods of control devised. The life histories of several species of chicken lice were also followed, this being the first time in which insects of this group have been carried through their life cycle. More effective methods of control of lice on poultry have been determined as a result of these studies. Previous investigations were of a preliminary nature.

Assignment.—F. C. Bishopp, W. E. Dove.

Proposed expenditures, 1916-17.—\$1,300.

Total, Investigation of Insects Affecting the Health of Animals, \$13,250, including \$2,100 statutory.

Total, Miscellaneous Insect Investigations, \$64,920, including \$8,540 statutory. This total does not include \$1,600 allotted to project "General Administration."

GIPSY MOTH AND BROWN-TAIL MOTH INVESTIGATIONS.**SUPERVISION.****Supervision:**

Object.—To supervise and direct the scientific and practical activities and business affairs of the gipsy moth and brown-tail moth investigations, including miscellaneous office, laboratory, and storehouse expenses, general supplies, and fixed charges which can not be readily prorated against the various projects.

Cooperation.—Federal Horticultural Board, Forest Service, and various State entomologists, foresters, and nursery inspectors.

Location.—Principal office, Boston, Mass. Principal laboratory, Melrose Highlands, Mass. The infested territory covers about one-third the area of New England; isolated colonies occur also in New York and Ohio.

Date begun.—1906.

Assignment.—A. F. Burgess.

Proposed expenditures, 1916-17.—\$22,190, including \$9,730 statutory (research, \$17,084; regulation, \$5,106).

[Research.]

LABORATORY AND FIELD INVESTIGATIONS.

Insects Parasitic on Moths:

Object.—To study the habits and life histories of the imported parasites and natural enemies of the gipsy and brown-tail moths; to determine the extent to which these parasites are increasing under field conditions in this country and ascertain their values as enemies of the insects concerned; also to collect and colonize the beneficial species in areas where they do not now exist in the infested territory.

Procedure.—Parasites and natural enemies of the gipsy moth and brown-tail moth have been introduced into New England from European countries and Japan. Colonies have been liberated in the worst infested areas in the field, and collections are made from year to year in order to determine the increase or decrease of the parasites and their hosts, and also for the purpose of securing material for liberating colonies in parts of the infested region where these beneficial species do not exist. In connection with this work it is necessary to study carefully the life histories and habits of the natural enemies concerned, in order that the work may be carried on intelligently. The interrelations between the parasites and their hosts, as well as factors in this country which may be responsible for decrease in parasitism, must also be carefully investigated.

Cooperation.—State experiment stations, entomologists, and moth superintendents in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

Location.—Portland, Me., Melrose Highlands, Mass., and a large number of localities in the New England States where parasitic material has been liberated.

Date begun.—1906.

Results.—Information has been disseminated as to the character and habits of the parasites imported and their value in moth control.

Assignment.—S. S. Crossman.

Proposed expenditures, 1916-17.—\$27,280.

Natural Increase of the Gipsy Moth under Field Conditions:

Object.—To determine the natural increase of the gipsy moth under field conditions and the relation of food plants, natural enemies, etc., to the control of this insect.

Procedure.—Studies are being made in about 200 selected infested areas, in order to determine the natural increase of the gipsy moth under field conditions. Selections are made in different types of woodland in places where parasites have been introduced, to check against other localities where none existed. The effect of defoliation on tree growth is carefully noted and definite records kept from year to year on the increase or decrease of the moth under field conditions.

Location.—Maine, New Hampshire, and Massachusetts.

Date begun.—1911.

Results.—Several relations of natural enemies to moth increase determined.

Probable date of completion.—February 1, 1917.

Assignment.—C. W. Minott.

Proposed expenditures, 1916-17.—\$15,500.

Feeding Habits of the Gipsy Moth:

Object.—To determine the feeding habits of gipsy-moth larvæ in all stages and the food plants upon which this species can not develop.

Procedure.—This work has been carried on by means of feeding gipsy-moth caterpillars in each stage on the common plants which occur in New England. The results of this work are checked by field observations.

Location.—Melrose Highlands, Mass.

Date begun.—1912.

Results.—The relation of food plants to the increase of the gipsy moth has been partially determined. A report covering most of the experiments has been published.

Probable date of completion.—January 1, 1917.

Assignment.—F. H. Mosher.

Proposed expenditures, 1916-17.—\$2,000.

Relation of Wilt to Gipsy-Moth Control:

Object.—To determine the identity of the disease known as the "wilt" and its relation and effect on the increase of the gipsy moth.

Relation of Wilt to Gipsy-Moth Control—Continued.

Procedure.—Technical laboratory studies are being carried on to determine the identity of the organism. Field observations to determine the relation of temperature and humidity to the prevalence and increase of the disease are also undertaken during the summer.

Cooperation.—Bussey Institution of Harvard University.

Location.—Melrose Highlands and Forest Hills, Mass.

Date begun.—1912.

Results.—Information has been secured on the dissemination of this disease; also much information as to its identity.

Probable date of completion.—January 1, 1917.

Assignment.—R. W. Glaser, J. W. Chapman, A. W. Young.

Proposed expenditures, 1916-17.—\$8,720.

Secondary Insects:

Object.—To determine the effect of secondary insects on trees that have been defoliated by the gipsy moth.

Procedure.—This work is being carried on principally through field observations, which are made as opportunity permits in the infested area. Records of injury to trees are being collected, a considerable amount of data is being secured in the field, and a few laboratory experiments on the life histories of secondary insects are being conducted.

Location.—Selected areas in Maine, New Hampshire, and Massachusetts.

Date begun.—1913.

Results.—The relation of secondary insects to the death of defoliated trees has been partially determined.

Probable date of completion.—1916.

Assignment.—H. A. Preston.

Proposed expenditures, 1916-17.—\$200.

Dispersion of Gipsy Moth:

Object.—To determine the means by which the gipsy moth spreads to new territory.

Procedure.—The information in regard to the dispersion of the gipsy moth is secured principally by using large screens coated with "tanglefoot," upon which are caught small caterpillars of the gipsy moth that are transported by the wind.

Location.—Selected areas in Maine, New Hampshire, and Massachusetts.

Date begun.—1911.

Results.—The relation of air currents to the dispersion of gipsy-moth caterpillars has been determined; published in Bureau of Entomology Bulletin 119.

Probable date of completion.—1917.

Assignment.—C. W. Collins.

Proposed expenditures, 1916-17.—\$4,000.

Introduction of Natural Enemies:

Object.—To carry on such work in foreign countries as may be necessary to secure natural enemies or information on parasites and diseases of the brown-tail and gipsy moth.

Procedure.—Arrangements will be made, if possible, to secure collections of certain parasites of the gipsy and brown-tail moths, which have been received only in small numbers.

Cooperation.—Entomologists in foreign countries.

Date begun.—1906.

Results.—About 30 species of parasites and natural enemies have been introduced, and of these 7 species are increasing and assisting in controlling the gipsy moth and the brown-tail moth.

Assignment.—A. F. Burgess.

Proposed expenditures, 1916-17.—\$14,800.

Testing Insecticides and Material for Banding Trees:

Object.—To test new insecticides and methods of spraying or banding trees, in order to enable control work to be carried on more efficiently and economically.

Procedure.—New insecticides will be given field and laboratory tests for the purpose of determining whether the use of any of them is feasible.

Location.—Melrose Highlands, Mass.

Date begun.—1914.

Assignment.—A. F. Burgess.

Proposed expenditures, 1916-17.—\$2,000.

Relation of Fungous Diseases to Gipsy and Brown-Tail Moth Control:

Object.—To study the effect of fungous diseases on the gipsy moth and the brown-tail moth, including a study of the diseases affecting the eggs of the gipsy moth; to determine whether the fungous disease of the gipsy-moth caterpillar, which was introduced from Japan several years ago, has become established in New England; and to determine the effect of fungous diseases in controlling the brown-tail moth.

Procedure.—Studies of the diseases mentioned will be conducted in the laboratory, and observations and collections made in the field to determine the benefit resulting from their use in combating the moths.

Cooperation.—Bureau of Plant Industry.

Location.—Melrose Highlands, Mass.

Date begun.—1916.

Assignment.—J. N. Summers, A. T. Speare.

Proposed expenditures, 1916-17.—\$2,500.

Total, Laboratory and Field Investigations, \$77,000, including \$2,520 statutory.

SCOUTING AND EXTERMINATION WORK.**Scouting and Extermination Work:**

Object.—To determine the area infested by the gipsy moth and the brown-tail moth, for the purpose of preventing the spread of these insects, and to apply exterminative measures in the territory where the best results can be secured in suppressing these pests.

Procedure.—Careful examinations are made by trained men of the towns immediately outside the area known to be infested by the gipsy moth, in order to determine the spread of this insect. In the region from Lake Winnepesaukee to Long Island Sound the towns along the infested border are carefully treated each year in order to hold back the spread of infestation as much as possible. Careful examinations are made of isolated colonies outside the solid infested area in New England, and treatment is applied whenever the States concerned are unable to bear the expense of all the work.

Cooperation.—State entomologists, foresters, and moth superintendents in the States concerned.

Location.—New England, New York, New Jersey, and Ohio.

Results.—The spread of the gipsy moth is determined annually, and many infestations in the outside territory have been exterminated.

Assignment.—L. H. Worthley.

Proposed expenditures, 1916-17.—\$165,430.

RELATION OF SILVICULTURE TO GIPSY-MOTH CONTROL.**Relation of Silviculture to Gipsy-Moth Control:**

Object.—To determine the relation of silvicultural condition to gipsy-moth infestation, and to demonstrate the best methods of handling forest growth so as to render it unfavorable to gipsy-moth attack; to determine the most profitable utilization of products cut.

Procedure.—In order to carry on this work sample plots have been selected and thinned to different percentages of favored and unfavored food.

Cooperation.—Forest Service, State foresters, entomologists, and moth superintendents in the infested territory.

Location.—Selected wood lots in the infested territory in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

Date begun.—1913.

Results.—Experiments have not been conducted for a sufficient length of time to show permanent results.

Assignment.—G. E. Clement.

Proposed expenditures, 1916-17.—\$5,000, including \$4,320 statutory.

[Regulation.]

QUARANTINE AND INSPECTION OF NURSERY, FOREST, AND QUARRY PRODUCTS.**Quarantine and Inspection of Nursery, Forest, and Quarry Products:**

Object.—To provide for the inspection of plants and forest and quarry products, in order to prevent the dissemination of the gipsy moth and the brown-tail moth from infested areas.

Quarantine and Inspection of Nursery, Forest, and Quarry Products—Continued.

Procedure.—All products mentioned in the project title are inspected by competent assistants and certified to be free from gipsy moth and brown-tail moth infestation before they are allowed to be moved to points outside the infested area.

Cooperation.—Federal Horticultural Board and State entomologists and inspectors in the infested territory.

Location.—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

Date begun.—1912.

Results.—This work has resulted in preventing the spread of the gipsy moth and the brown-tail moth in many localities outside of the present infested area.

Assignment.—D. M. Rogers.

Proposed expenditures, 1916-17.—\$52,000.

Total, Gipsy Moth and Brown-Tail Moth Investigations, \$321,620, including \$16,570 statutory (research, \$264,514; regulation, \$57,106).

BUREAU OF BIOLOGICAL SURVEY.

GENERAL ADMINISTRATION.

Office of Chief:

Object.—General supervision of the business and other activities of the bureau, including the editing of manuscripts submitted for publication.

Cooperation.—Other Federal bureaus, departments, boards, and commissions.

Location.—Washington, D. C.

Date begun.—1885.

Assignment.—H. W. Henshaw, chief, E. W. Nelson, assistant chief.

Proposed expenditures, 1916-17.—\$16,900.

Office of Chief Clerk:

Object.—General supervision of the fiscal affairs of the bureau, of the clerical force and janitor service, the handling of mails, operation and maintenance of central file and property room, and all matters pertaining to appointments, pay rolls, and leaves of absence.

Cooperation.—Other offices of the department and other departments.

Location.—Washington, D. C.

Date begun.—1911.

Assignment.—E. J. Thompson.

Proposed expenditures, 1916-17.—\$20,850.

Total, General Administration, \$37,750, including \$25,190 statutory (regulation, \$32,875; research, \$4,800; extension, \$75).

GAME PRESERVATION.

ENFORCEMENT OF THE LACEY ACT.

Supervision:

Object.—The organization and conduct of the activities of this group of projects, including correspondence, information files, and relations to other organizations.

Cooperation.—Solicitor's office, Department of Justice, State game officials, Customs Service, Treasury Department, Bureau of Animal Industry, and organizations and individuals interested in the protection and conservation of wild life.

Location.—Washington, D. C.

Date begun.—1900.

Assignment.—W. F. Bancroft.

Proposed expenditures, 1916-17.—\$4,800 (regulation, \$4,000; research, \$800).

[Regulation.]

Interstate Commerce in Game:

Object.—The enforcement of sections 242 and 243 of the Criminal Code of the United States regulating interstate shipment of game.

Procedure.—Field investigations are made of interstate traffic in game killed or shipped in violation of State laws. Evidence of violations is secured from individuals, dealers, and transportation companies and submitted to the Solicitor's office for transmission to the Department of Justice and to State game officials.

Location.—Throughout the United States, but mainly in the Mississippi Valley, Middle and South Atlantic States, Arkansas, Missouri, Illinois, New York, Maryland, Virginia, Utah, and Colorado.

Date begun.—1900.

Results.—Through the activities of inspectors approximately 60 cases were reported to the Solicitor's office during the fiscal year 1916, and a large number of cases are now under investigation. As a result of these prosecutions and warnings many former offenders have stopped violating the law, and most of the express companies are refusing to accept illegal shipments.

Assignment.—W. F. Bancroft.

Proposed expenditures, 1916-17.—\$8,700.

Importation of Foreign Birds and Mammals:

Object.—To prevent the introduction from foreign countries of injurious species of birds and mammals.

Procedure.—Six experienced scientific men are employed at main ports of entry to make inspections of shipments of imported birds and mammals, to identify the species in such shipments, and determine whether any of them are prohibited from entry under section 241 of the Criminal Code of the United States.

Cooperation.—Customs Service, Treasury Department, and Bureau of Animal Industry.

Location.—Washington, D. C., New York, Philadelphia, San Francisco, Honolulu, and other ports when necessary.

Date begun.—1900.

Results.—Prevention of the admission of numerous species of birds and mammals which might become destructive pests, such as the mongoose.

Assignment.—W. F. Bancroft, T. S. Palmer.

Proposed expenditures, 1916-17.—\$1,700.

Inspection and Quarantine of Quail:

Object.—To prevent the introduction of quail disease from northern Mexico among game birds in the United States.

Procedure.—A quarantine and inspection service is maintained over all shipments of quail from Mexico during the season when such importations are permitted.

Cooperation.—Bureau of Animal Industry.

Location.—New York City, Eagle Pass, Tex., and possibly other points in Texas on the Rio Grande, to be determined later.

Date begun.—1914.

Results.—Inspection and quarantine of shipments, including about 10,000 quail which arrived at Eagle Pass, Tex., and New York City, up to January 22, 1916, when further importations were suspended on account of the presence of quail disease. About one-third of these quail arrived at New York and practically all of the birds died en route or during quarantine. In addition to quail disease, some of the birds were found to be affected with bird pox, and at least 400 died from this disease.

Assignment.—W. F. Bancroft, T. S. Palmer.

Proposed expenditures, 1916-17.—\$100.

[Research.]

Publication of Information Concerning Game Laws:

Object.—Compilation, publication, and distribution of information concerning game, game laws, interstate commerce in game, and importation of foreign birds.

Procedure.—Copies of all State and Federal game laws enacted and all bills introduced affecting game matters in general are secured, and court decisions bearing upon game legislation are compiled. In addition, periodical and other publications are searched for data on game and game laws.

Cooperation.—State officials and organizations and individuals concerned with the protection and conservation of wild life.

Location.—Washington, D. C.

Date begun.—1900.

Results.—The annual summary of the game laws, two posters, and a directory of game officials were issued at the beginning of the hunting season. The bulletin this year has been published in an edition of 120,000 copies and the cost reduced to about 1½ cents per copy. Five additional sets of ready reference-card maps were issued containing information relating to matters of special interest to State game departments and others concerned with game conservation.

Assignment.—W. F. Bancroft, T. S. Palmer.

Proposed expenditures, 1916-17.—\$3,000.

Total, Enforcement of the Lacey Act, \$18,300, including \$3,700 statutory (regulation, \$14,500; research, \$3,800).

ESTABLISHMENT AND MAINTENANCE OF MAMMAL AND BIRD RESERVATIONS.**Supervision:**

Object.—The organization and conduct of the activities of this project group, including correspondence, information files, and relations to other organizations in allied work.

Cooperation.—National Association of Audubon Societies.

Supervision—Continued.*Location.*—Washington, D. C.*Date begun.*—1905.*Assignment.*—T. S. Palmer.*Proposed expenditures, 1916-17.*—\$3,600 (regulation, \$3,450; extension, \$150).

[Regulation.]

General Maintenance of Reservations and Refuges:*Object.*—To preserve and perpetuate the bird life of the country, as well as game mammals, for the benefit of the public, both from an economic and recreational standpoint.*Procedure.*—An inspection and warden service is maintained and general supervision exercised over the bird and mammal preserves or reservations in charge of the Department of Agriculture.*Cooperation.*—War Department, Navy Department, Reclamation Service, United States Coast Guard, Bureau of Fisheries, Forest Service, National Association of Audubon Societies, American Bison Society, Boone and Crockett Club, State game officials, and individuals.*Location.*—At reservations in 20 States, Alaska, Hawaii, and Porto Rico.*Date begun.*—1909.*Results.*—Protection of Federal bird and game preserves, improvement of conditions thereon, and a general increase of bird life reported from practically all the reservations; also a satisfactory increase of game animals on refuges; preservation from decrease of some important species.*Assignment.*—T. S. Palmer.*Proposed expenditures, 1916-17.*—\$14,600.**Montana National Bison Range:***Object.*—Care of buffalo and other big game animals now on or which may be transferred to the range.*Procedure.*—Permanent warden service is maintained. The animals on the range are cared for, hay is stored for winter use, the water supply is kept in good order, and fences and buildings are kept in repair.*Cooperation.*—Reclamation Service.*Location.*—Dixon, Mont.*Date begun.*—1908.*Results.*—Buildings and fences have been repaired and irrigating ditches improved. All animals on the range are in excellent condition, and the bison herd has increased from the original 37 head to over 140. Twenty-six additional elk were placed on the range this spring, making the number now about 60. The number of antelope is 18.*Assignment.*—T. S. Palmer.*Proposed expenditures, 1916-17.*—\$2,500.**Wind Cave National Game Preserve:***Object.*—The establishment and maintenance of a national game preserve in the Wind Cave National Park.*Procedure.*—The purchase of additional land, keeping fences and buildings in repair, and maintaining an efficient warden service to protect the game animals located on the preserve.*Cooperation.*—Department of the Interior, American Bison Society, and Boone and Crockett Club.*Location.*—Wind Cave National Park, S. Dak.*Date begun.*—1912.*Results.*—All private holdings of land within the Wind Cave National Park have been acquired by the department. A game preserve of 4,160 acres has been inclosed by a substantial 88-inch woven-wire fence, and this fence has been protected by clearing a fire guard along the exposed sections. Headquarters, barns, and other buildings are in good condition. The big game now on the refuge includes 14 buffalo, 39 elk, and 7 antelope. Twenty-five of these elk were transferred from the Yellowstone National Park in February, 1916. Preparations have been made to acquire 6 more buffalo.*Assignment.*—T. S. Palmer.*Proposed expenditures, 1916-17.*—\$2,700 (\$1,200 carried over from 1916).

Winter Elk Refuge:

Object.—To insure perpetuation of the elk in Wyoming by the establishment of a permanent winter refuge, on which sufficient hay may be raised for the animals, and a free range thence to summer feeding grounds.

Procedure.—The acquiring of land for a winter range and the production of hay sufficient to insure feed for the elk herds during severe winters in order to prevent great losses by starvation. This includes the fencing and maintenance of the hay lands in productive condition, the gathering and stacking of the crop, and feeding the elk when necessary in winter.

Location.—Jackson Hole, Wyo.

Date begun.—1912.

Results.—One thousand seven hundred and sixty acres of land have been purchased and 840 acres of public land added, making the present area of the reservation 2,600 acres. About 500 tons of hay raised on the refuge in 1915 were consumed by the elk during the past winter. At one time in January, 1916, there were about 4,000 elk on the feeding grounds in and near the refuge.

Assignment.—T. S. Palmer.

Proposed expenditures, 1916-17.—\$4,000.

Sullys Hill National Game Preserve:

Object.—The establishment and improvement of a game preserve in the Sullys Hill National Park for the preservation of birds and game mammals.

Procedure.—The construction of a suitable inclosure, including necessary corrals, sheds, and buildings, for the proper care and maintenance of the animals and birds to be placed therein.

Cooperation.—Department of the Interior, American Bison Society, and State game officials.

Location.—Sullys Hill National Park, N. Dak.

Date begun.—1914.

Results.—A contract was let for the completion during the past fiscal year of a substantial 88-inch woven-wire fence about 6 miles in length, inclosing the national park. The contract price for the fence was \$9,462, including material.

Assignment.—T. S. Palmer.

Proposed expenditures, 1916-17.—\$5,000.

[Extension.]

Restocking Reservations:

Object.—To stock national game preserves and other reservations with big game and game birds adapted thereto.

Procedure.—To capture and transport elk from Jackson Hole, Wyo., and the Yellowstone National Park for distribution to Federal and State reservations and municipal parks; also to secure antelope and other game mammals and birds and transport them to reservations.

Cooperation.—Department of the Interior, Forest Service, State game departments, and individuals.

Location.—Various points in Colorado, Utah, South Dakota, and elsewhere.

Date begun.—1911.

Results.—(1) During 1916: One hundred head of elk have been transferred from the Yellowstone National Park, as follows: To national forests in Colorado, 50 head; to the Montana National Bison Range, 25 head; and to the Wind Cave National Park, S. Dak., 25 head. Arrangements were also made for the transfer of 6 buffalo from the Yellowstone National Park to the Wind Cave National Park during the month of June.

(2) Prior to 1916: Elk transported to various parts of the country, including parks and national forests situated in the States of Washington, Oregon, Montana, Colorado, Utah, South Dakota, Nebraska, and Oklahoma.

Assignment.—T. S. Palmer.

Proposed expenditures, 1916-17.—\$1,000.

Total, Establishment and Maintenance of Mammal and Bird Reservations, \$33,400, including \$2,200 statutory (regulation, \$32,250; extension, \$1,150).

Total, Game Preservation, \$51,700, including \$5,900 statutory (regulation, \$46,750; research, \$3,800; extension, \$1,150).

ECONOMIC INVESTIGATIONS.

Supervision:

Object.—To organize, inspect, and direct the staff employed in the execution of the law providing for investigating the food habits of North American birds and mammals in relation to agriculture, horticulture, and forestry, and to carry on clerical and other routine work necessary to the proper conduct of this project group.

Cooperation.—Forest Service and State experiment stations.

Location.—Washington, D. C., and many points in the United States mentioned under "Location" in other projects of this group.

Date begun.—1905.

Assignment.—A. K. Fisher.

Proposed expenditures, 1916-17.—\$11,530 (regulation, \$9,530; research, \$2,000).

[Regulation.]

Relation of Native and Introduced Mammals to Agriculture:

Object.—To devise and demonstrate methods for controlling wild mammals destructive to agriculture, animal husbandry, range lands, and forestry; to collect information relative to the kind and amount of damage done by them; and to publish and otherwise disseminate this information.

Procedure.—Experiments in poisoning, trapping, fumigating, and otherwise destroying noxious mammals; to determine the most practical and economical methods for controlling them; and work by field parties in destroying injurious mammals on Government reserves, public range lands, and Government tracts, which serve to keep up infestation of private lands of agricultural districts. Demonstrations and advisory assistance will be given to individuals and organizations in the repression of mammal pests on private lands.

Cooperation.—Forest Service, Indian Service, and Reclamation Service cooperate in destroying injurious animals on lands under their control. The North Dakota Agricultural Experiment Station cooperates in a State-wide demonstration of methods to control rodent pests. County officers have cooperated in connection with jack-rabbit control. County agricultural agents throughout the West have lent valuable cooperative aid in planning and calling demonstration meetings and assisting in organizing extermination campaigns within their jurisdiction. Cooperative work is also carried on with individuals and with stockmen's and farmers' clubs in rodent-infested areas.

Location.—Prairie-dog extermination work is being conducted on the Coconino, Sitgreaves, and Prescott National Forests of Arizona, the Manzano, Carson, Alamo, and Datil Forests of New Mexico, the Cochetopa, Rio Grande, and Leadville Forests of Colorado, the Custer National Forest and Crow Indian Reservation of Montana, and also on extensive areas of public lands in the vicinity of Newcastle and Manville, Wyo., and Ardmore, S. Dak. Pocket-gopher eradication is in progress on the Ochoco National Forest of Oregon and the Tahoe and Sequoia Forests of California. Ground squirrels are being exterminated on the Fort Totten Indian Reservation of North Dakota. Plans for the fiscal year 1917 include the continuance of work on these areas and on a number of additional forests. Demonstration work and advisory assistance in the control of noxious animals on privately owned areas is being carried on during favorable seasons in California, Oregon, Washington, North Dakota, Montana, Idaho, Utah, Nevada, Wyoming, Colorado, South Dakota, Nebraska, Kansas, Oklahoma, and Texas.

Date begun.—1905.

Results.—(1) During 1916: More economical and efficient poison formulas have been devised and perfected until it is now possible to control prairie dogs and ground squirrels on heavily infested areas for approximately 5 cents per acre. The more practical methods of control have also resulted in increased cooperation by landowners. At the end of the poisoning season in October, 1915, 1,051,184 acres of Government land had been practically cleared of prairie dogs since the beginning of the fiscal year in July. This brings the total acreage of valuable grazing lands under Government control which have been freed of prairie dogs since the commencement of this work up to approximately 1,500,000 acres, resulting in a 50 per cent improvement of forage conditions. This added forage is sufficient to support live stock valued at \$1,200,000 and is worth from \$17,000 to \$20,000 annually in grazing permits.

Pocket gophers have been eradicated from 7,770 acres of the best grazing lands on forests in California and Oregon, and seed-eating rodents have been

Relation of Native and Introduced Mammals to Agriculture—Continued.

destroyed on replanted areas in national forests in California, South Dakota, and Florida.

The demonstration of methods of ground-squirrel control in the State of North Dakota, which has been carried on during the past two years in cooperation with the North Dakota Experiment Station, developed during the fiscal year 1916 into a systematic organization which includes seven counties in the northern part of the State. Cooperative poisoning was taken up with a township as a unit, and the North Dakota State law which provides for the extermination of ground squirrels on all resident and nonresident lands within a township was put into effect. The result of this organization has been the proper distribution of the enormous quantity of five-eighths of a ton of strychnine within this area during March, April, and May, 1916. This systematic covering of large areas of contiguous territory is the only way by which permanent relief may be had from the depredations of rapidly spreading rodent pests, and under the system being employed in North Dakota a total extermination of the ground squirrels may eventually be expected.

Farmers' Bulletin 702, "Cottontail Rabbits in Relation to Trees and Farm Crops," has been issued during the past fiscal year. Ready for publication: "Methods for Destroying Pocket Gophers." In preparation: "Directions for Poisoning and Trapping Wolves and Coyotes."

(2) Prior to 1916: Investigations have included methods of controlling prairie dogs, ground squirrels, jack, cottontail, and snowshoe rabbits, pocket gophers, meadow mice, woodchucks, cotton rats, muskrats, woodrats, kangaroo rats, white-footed mice, chipmunks, common rats, and house mice, as well as moles. The results of these investigations have been widely disseminated by means of publications and demonstrations. Twenty-five publications have been issued covering the control of injurious mammals.

Assignment.—A. K. Fisher.

Proposed expenditures, 1916-17.—\$96,610.

Destruction of Predatory Animals in National Forests and on the Public Domain:

Object.—Systematic and economical control on the Government reserves and public domain of wolves, coyotes, and other mammals destructive to live stock; control and suppression of wild animals infected with rabies, an epidemic of this disease having appeared among predatory wild animals in the western United States; collection of information on the losses occasioned by such animals; and the discovery of breeding dens and destruction of females and their young.

Procedure.—The infested region is divided into eight districts, each under the supervision of a competent inspector. The work of these local inspectors is under the immediate direction of an inspector at large, who is constantly in the field studying and improving methods. Hunters and trappers are employed in each district at salaries ranging from \$75 to \$115 per month, including the use of horses and equipment furnished by them. The hunters are not allowed to receive bounties from any source, and the skins of the fur-bearing animals taken are received and sold by the bureau and the proceeds turned into the Treasury. Hunters are placed where loss of live stock is greatest, rather than in sections where predatory animals may be more numerous but the losses light.

Cooperation.—The Indian Service will assist in the work. The Forest Service is cooperating and will give valuable assistance by keeping in touch with the work and informing the bureau concerning conditions and the results accomplished. Cooperation will also be carried on with State and local authorities, with national, State, and county live-stock associations, and with individuals.

Location.—National forests and the public domain.

Results.—Perfection of organization, improvements in methods, a substantial number of predatory animals destroyed, and reductions in loss of live stock.

Date begun.—1915.

Assignment.—A. K. Fisher, S. E. Piper.

Proposed expenditures, 1916-17.—\$125,000.

Suppressing Spread of Rabies in Predatory Wild Animals:

Object.—An epidemic of rabies has appeared among the predatory wild animals, including coyotes, bobcats, and others, in the western United States. This disease is being communicated by these animals to human beings and to stock and other domestic animals. The object of this project is the control and suppression of the wild animals which are spreading the disease.

Suppressing Spread of Rabies in Predatory Wild Animals—Continued.

Procedure.—The only satisfactory method for the suppression of this disease is the destruction of the afflicted predatory animals. The infested region having been divided into districts under the project, "Destruction of Predatory Animals in National Forests and on the Public Domain," with an inspector in charge of each district, the work will be supervised by the existing organization. Additional inspectors and hunters will be employed. The methods which obtain in the predatory-animal work will be followed.

Cooperation.—State, national, and local stock associations, the Forest Service, and individuals.

Location.—Rabies-infested and adjacent territory in Oregon, California, Nevada, Idaho, and Utah.

Results.—Organization has been effected and work is in progress.

Date begun.—March 4, 1916.

Assignment.—A. K. Fisher, S. E. Piper.

Proposed expenditures, 1916-17.—\$159,500 (including \$34,500 unexpended balance of special emergency appropriation carried in the urgent deficiency act of Feb. 28, 1916).

Destruction of Ground Squirrels in National Forests and on Other Public Lands:

Object.—The development and application of practical methods to control ground squirrels in national forests and on other public lands, to prevent injury by them to range areas and invasion by them of private lands surrounded by or adjacent to Government lands. These rodents are carriers of the bubonic plague.

Procedure.—Poisoning and otherwise destroying these animals in infested areas by field parties under experienced assistants.

Cooperation.—Landowners cooperate by poisoning private lands within and adjacent to the areas of Government land being poisoned, thereby preventing reinfestation.

Location.—Work has been and is being performed in seven national forests, the Tule Indian Reservation, and Government lands near San Benito, in California; also in the Toiyabe National Forest, Nevada, and the Colorado National Forest, Colorado.

Date begun.—1909.

Results.—From July 1, 1915, until the end of the ground squirrel season in August, 93,360 acres were cleared of ground squirrels in California at a cost of 4.6 cents per acre. This brings the total acres of Government lands in California which have been cleared of this pest up to 264,122. The cost per acre of exterminating this rodent has been steadily decreasing as the efficiency of the poisons used have increased and as the methods of distribution have become more systematized.

Assignment.—A. K. Fisher.

Proposed expenditures, 1916-17.—\$15,000.

(Control of Crawfish: Project completed. Methods of controlling crawfish, a serious pest of cotton, particularly in the Houston clay lands of Mississippi and Alabama, have been discovered and demonstrated.)

[Research.]

Relation of Native and Introduced Birds to Agriculture:

Object.—To determine what native and introduced birds are beneficial to agriculture, horticulture, and forestry, and what species are injurious; to publish and otherwise disseminate this information; to devise and recommend methods of encouraging the beneficial species and controlling the injurious ones; and to act as an information bureau upon all points touching this project.

Procedure.—The relations of birds to agriculture are ascertained by work along two main lines: Field observation, including the collection of stomachs of birds, and laboratory examination and tabulation of the contents of stomachs. Future work will deal with groups of birds not yet studied, with revisions of earlier investigations, and with local problems as to the relation of birds to outbreaks of destructive pests. Methods of attracting birds in all parts of the United States will be published. In cases of damage by birds, means of control will be sought. The investigation of the economic status of the introduced starling in the northern Atlantic States will be continued. Further studies will be made of the feeding habits and natural food supply of wild fowl.

Relation of Native and Introduced Birds to Agriculture—Continued.

Cooperation.—Entomologists and botanists in the United States National Museum, the Bureaus of Entomology and Plant Industry, and in other institutions. Individuals also assist in identifications, and much material is contributed by them.

Location.—Washington, D. C., New York, Massachusetts, New Jersey, Connecticut, Rhode Island, Utah, and North Dakota; cooperators in numerous localities.

Date begun.—1885.

Results.—(1) During 1916: Examination of bird stomachs by groups was completed for two species of crossbills, two of redpolls, the pine grosbeak, the evening grosbeak, three species of godwits, three of curlews, the avocet, the chewink, the scarlet tanager, and the red-eyed vireo. Examinations were brought up to date for the green-winged and blue-winged teals, 7 species of swallows, the wrens, thrashers, and mockers, about 17 species in all, the creeper, 4 species of nut-hatches, 8 species of titmice and chickadees, the wren-tit, the starling, fish crow, ravens, and about 13 species of owls. Publications issued: Department Bulletins 280, "Food Habits of the Thrushes of the United States," and 326, "Birds of Porto Rico," and Department Yearbook, 1915, "Winter Crow Roosts." In press: Farmers' Bulletin 755, "Common Birds of Southeastern United States in Relation to Agriculture." Manuscripts completed: "Crows and Their Relation to Man," "The Swallows—a Family of Valuable Native Birds," "Propagation of Wild Duck Foods," and "Index to Papers Relating to the Food of Birds by Members of the Biological Survey in Publications of the United States Department of Agriculture, 1912–1915." In preparation: "The Wild Ducks and Duck Foods of the Sandhill Region of Nebraska" (part relating to foods), "How to Attract Birds in Northwestern United States," "The Care and Management of Canaries," and "The Food Habits of Some Winter Bird Visitors."

(2) Prior to 1916: (a) A fund of exact information on the relations of birds to agriculture that is unequalled anywhere has been built up. (b) Information on the economic status of no fewer than 490 species of birds has been published. This information and the arguments based upon it without doubt have been the greatest single factor contributing to the enactment in the United States of the best system of bird protective laws in existence. (c) Important information has been disseminated upon the provision of nest boxes for birds, increasing their food supply, and otherwise augmenting their numbers. It has been shown that taking proper steps along these lines results in a several-fold increase in the bird population of treated areas and means decreased losses from the depredations of injurious insects. (d) Similar work has been carried on looking toward the improvement of feeding grounds of our most important group of game birds, the wild ducks. Valuable results have already been accomplished, and an increasing number of game commissions and organizations of sportsmen are making use of these results.

Assignment.—A. K. Fisher, W. L. McAtee.

Proposed expenditures, 1916–17.—\$22,300.

Rearing Fur-Bearing Animals:

Object.—To determine the best methods of feeding, confining, and otherwise handling fur-bearing animals, especially foxes, minks, and martens; to determine the species most suitable for domestication; to produce improved strains by selective breeding; to investigate the effects of temperature on fur growth; and to test methods of dressing peltries and of caring for dressed furs.

Procedure.—Animals are kept in different kinds of inclosures and fed on different kinds of food. Their behavior and condition are recorded. They are mated with reference to specific characteristics. Individuals from the same source will be kept in localities having decided climatic differences. They will be transferred from one climatic condition to another at different stages of moult and kept at different degrees of temperature at the same station. Skins will be dressed by different processes and stored under different conditions. The experience of others in each of these lines will be obtained.

Cooperation.—Many individuals engaged in fur farming have sent in reports of their methods and results.

Location.—Washington, D. C., Linden, Md., and Chesterfield, N. Y.

Date begun.—1912.

Results.—(1) During 1916: An assistant visited Alaska and studied methods of handling silver and blue foxes in confinement in connection with a general study of the fur animals of that Territory. Land was leased in Chesterfield, N. Y., to be used as an experimental fur farm, and the organization for carrying on

Rearing Fur-Bearing Animals—Continued.

experiments there was perfected. Plans were completed for temporary buildings, including a workshop and storehouse, an ice house, and inclosures for minks, martens, blue foxes, and cross foxes. The mink and marten pens and the workshop and storehouse were under construction. Publications issued: Department Bulletin 301, "Silver Fox Farming in Eastern North America," and Farmers' Bulletin 706, "Laws Relating to Fur-Bearing Animals, 1915."

(2) Prior to 1916: Many details of value in practical fur farming have been determined with minks and martens, and a large fund of information on this subject has been gathered. Five farmers' bulletins and eleven circulars relating more or less directly to fur farming were issued prior to 1916.

Assignment.—A. K. Fisher, Ned Dearborn.

Proposed expenditures, 1916-17.—\$7,500.

Investigation of Disease of Wild Ducks in Salt Lake Valley, Utah:

Object.—Investigation of the great mortality among the wild ducks of the Salt Lake Valley, Utah, to determine its cause and to discover means of prevention.

Procedure.—Expert assistants will observe the progress of the trouble in the field, and experiments with captive birds to determine the cause of the mortality and to discover preventive measures which may be employed to save the ducks will be conducted. Studies of healthy birds necessary for comparison with diseased individuals will be made.

Cooperation.—The Bear River Club Co. has allowed to be erected a small building for laboratory purposes on the club grounds and, with the Duckville Gun Club and individuals, will furnish other facilities.

Location.—Salt Lake Valley, Utah, where experimental work will be carried on at the mouth of Bear River; also at the mouths of the Weber and Jordan Rivers, at Promontory Point, and at Locomotive Springs near Kelton.

Date begun.—1914.

Results.—Judging from investigations made thus far, it is believed that the main trouble is due to an alkali poison in the water, since affected birds treated with fresh water recover. Methods of relief, through draining stagnant pools, increasing the supply of flowing water when possible, and bringing affected birds to fresh water, are advocated. It has been found that part of the birds affected have lead poisoning from eating shot.

Probable date of completion.—1918.

Assignment.—A. K. Fisher, Alex. Wetmore.

Proposed expenditures, 1916-17.—\$3,500.

Total, Economic Investigations, \$440,940, including \$5,900 statutory (regulation, \$405,640; research, \$35,300).

[Research.]

BIOLOGICAL INVESTIGATIONS.**Supervision:**

Object.—Supervision and direction of field and laboratory investigations and general correspondence.

Location.—Washington, D. C., and throughout the United States where field work is being conducted.

Date begun.—1905.

Assignment.—E. W. Nelson.

Proposed expenditures, 1916-17.—\$3,160.

Biological Surveys of the States and Territories:

Object.—To determine the distribution, abundance, and habits of the birds and mammals of the States and the distribution of the principal plants, in order to secure information for publication which will be of use to the public in the conservation of the bird and mammal life and to obtain data by which the boundaries of the natural life zones may be determined. The life-zone work in each State serves as a unit in completing the mapping of the life zones of the entire United States.

Procedure.—Skilled field naturalists traverse the State, working the mountains, valleys, and plains in sufficient detail to learn the distribution of birds, mammals, and principal plants. Specimens of each of these groups are collected from many stations at varying altitudes when necessary for identification and study. Detailed field notes of the habits of birds and mammals are made, especially in reference to their food habits, and stomachs are saved for laboratory investigation. Reports are required from field men at the end of the work

Biological Surveys of the States and Territories—Continued.

at each temporary station covering observations on the physiography of the district, the characteristic vegetation, and the birds and mammals. This field work continues until the State is covered in sufficient detail to warrant final reports, which are prepared in Washington from a study of specimens and collation of field reports. Much information is gained also by correspondence and the study of specimens loaned by institutions and individuals.

Cooperation.—In North Dakota, the Agricultural Experiment Station, Agricultural College, State University, State Normal School, and individuals; in Oregon, the State University, the State game and fish commission, and individuals. In Arizona and Alabama much interest is shown in the work, and the State fish and game commissions and many individuals have given special aid.

Location.—Active field work on biological surveys will be continued in various parts of Oregon, Arizona, and Alabama. Field work has been practically completed in Wyoming, New Mexico, and North Dakota. Work on the biological survey of Montana, where considerable investigation along this line has been done in past years, is planned for the fiscal year 1917.

Date begun.—The general project was begun in 1889; work in New Mexico was begun in 1903; Alabama, 1908; Arizona, 1909; Wyoming, 1910; North Dakota, 1912; Oregon, 1914.

Results.—(1) During 1916: Field work in North Dakota was completed; work in Oregon, about 90 per cent completed; in Arizona, about 70 per cent completed. In Alabama, field work on birds was finished and the report completed and ready for publication.

(2) Prior to 1916: Field work in New Mexico has been completed, the report on life zones has been published, and reports on mammals and birds are being prepared; work in Texas completed, a report on life zones and on mammals published, and a report on birds practically completed; work in Colorado finished and a report on life zones and mammals published; work in Wyoming completed and reports on life zones and on mammals in preparation. In many other States a large quantity of work has been done and a great amount of data in the shape of field notes and specimens gathered, to be used later when it is possible to complete the work.

Publications issued: North American Faunas—No. 3, "Result of a Biological Survey of the San Francisco Mountain Region and Desert of the Little Colorado in Arizona," covering reports on life zones, birds, mammals, and reptiles; No. 16, "Results of a Biological Survey of Mount Shasta, California," covering reports on life zones, birds, mammals, and plants; No. 25, "Biological Survey of Texas," including reports of life zones, reptiles, and mammals; No. 33, "A Biological Survey of Colorado," including reports on the life zones and mammals; and No. 35, "Life Zones and Crop Zones of New Mexico." Ready for publication: North American Fauna, "Life Zone Investigations in Wyoming." In preparation: North American Faunas, "Bird Life of Texas," practically completed; "Birds of New Mexico," nearly completed; "Mammals of New Mexico," nearly completed; and "Birds of Alabama" (including reports on life zones and annotated list), completed.

Probable date of completion.—North Dakota, 1918; Oregon, 1918; Wyoming, 1916; Arizona, 1918; Alabama, 1917; New Mexico, 1917.

Assignment.—E. W. Nelson, Vernon Bailey.

Proposed expenditures, 1916-17.—\$15,050.

Investigations of Birds and Mammals of the Public Domain:

Object.—To secure and publish definite information concerning the habits and distribution of bird and mammal life of the public domain, particularly in the national forests and Federal preserves, with special reference to the fur bearers and species classed as game. This information is desired to assist in the conservation of valuable species, particularly game birds and mammals, and for the purpose of supplying accurate information necessary in the restocking of areas in which the species have become extinct. Information is also gathered concerning the habits and distribution of noxious species for use in connection with plans for their control. These field and laboratory investigations supply information which is constantly desired by institutions and individuals throughout the country, as well as by Government departments. They are necessary also for use in connection with other activities of the bureau.

Procedure.—Field naturalists conduct investigations throughout the United States, Alaska, and parts of Canada and Mexico, where observations are recorded, specimens collected, and detailed field reports made, which form the

Investigations of Birds and Mammals of the Public Domain—Continued.

basis for laboratory investigations and reports. Information is also gathered from individuals and institutions. Expert study is made of the specimens for the purpose of determining the number and relationship of the species of birds and mammals, in order that they may be differentiated, their ranges accurately mapped, and the information available properly collated. Reports are prepared from time to time for publication covering the field work of this project, also monographs of the little-known groups of mammals and birds, in order to supply information necessary in studying the relations of the species to agriculture and their value as game animals and as fur bearers.

Cooperation.—State game commissions, State and other universities, agricultural colleges, scientific societies, and individuals, both in the collection and contribution of information and the loan of specimens. Several men interested in large game and its conservation have made long and costly expeditions at their own expense to secure information and specimens to forward the investigations of the bureau, and in some cases have contributed money for these purposes.

Location.—Washington, D. C., and many points throughout the United States, Canada, and Mexico.

Date begun.—1885.

Results.—The accumulation of a vast fund of information concerning the bird and mammal life of North America, particularly the species valuable for game and as fur bearers and those injurious to agriculture. The data on file resulting from this project and allied lines of work have become so extensive that the Bureau of Biological Survey has now become a clearing house for information on these subjects. Letters of inquiry are constantly received from all parts of the United States, Canada, and Mexico concerning the identity of species, their habits, value, and relations to agriculture. State authorities also consult this section of the bureau for information concerning the identity of scalps submitted for bounties, in order to prevent fraud. Hundreds of maps have been prepared showing the distribution of game and other mammals in North America.

Numerous publications, especially technical monographs of mammals, have been prepared and published as a result of investigations under this project, and others are in progress. The more recently issued of these publications are: North American Faunas—No. 29, "North American Rabbits"; No. 31, "Revision of the Wood Rats"; No. 32, "A Systematic Synopsis of the Muskrats"; No. 34, "Revision of the Spiny Pocket Mice"; No. 36, "Revision of the American Harvest Mice"; No. 37, "Revision of the American Marmots"; No. 38, "Revision of the North American Moles"; No. 39, "The Pocket Gophers of the Genus *Thomomys*." Those in preparation are: "A Systematic Account of the Prairie Dogs," in press; "The North American Flying Squirrels," completed; "The Grizzly and Brown Bears of North America," nearly completed; and "The North American Rice Rats," nearly completed.

Assignment.—E. W. Nelson, Vernon Bailey.

Proposed expenditures, 1916-17.—\$9,180.

Bird Migration:

Object.—To determine for each species of bird in the United States its breeding and wintering places and the routes by which it passes from winter to summer home and return, and to determine the times of its migration and the extent of its wanderings out of its regular range. This information is for use in connection with studies of the relation of birds to agriculture and for the proper administration of the Federal migratory-bird law. It is also useful in the making of open and closed seasons for game birds in the various States.

Procedure.—Persons located in many parts of the United States interested in the study of birds and sufficiently acquainted with the species record the arrival and departure of the birds during migration, note the species which breed in their neighborhood and those which winter there, and report their results to the department. The reports of field men also supply much of this information. In addition, data are obtained from published information in scientific journals. These facts are collated in card files and the results plotted on maps, which thus show at a glance the movements of the species and their summer and winter homes. During 1916-17 the gathering and collating of data from available sources will be continued and efforts made to secure information concerning migratory waterfowl for use in connection with the administration of the migratory-bird law.

Bird Migration—Continued.

A census of the birds breeding on certain typical areas of farm, orchard, and forest land has also been undertaken, the reports being made by voluntary observers in various parts of the country, to ascertain the conditions most favorable for the useful species with the object of increasing their numbers.

Cooperation.—About 300 volunteer observers are now sending in migration reports and more than 300 are sending census reports.

Location.—Washington, D. C., and hundreds of localities throughout the United States and southern Canada.

Date begun.—1885.

Results.—Migration reports have been received from more than 2,000 volunteer observers. These notes, together with those obtained from publications and the observations of field men of the bureau, are tabulated on more than 1,000,000 cards. Final reports have been published on the migratory movements of 255 species, and bulletins on 52 species have been completed for publication. Provisional maps of the breeding ranges have been completed for each species breeding in the United States and about one-third of the breeding ranges of those breeding in Canada. The winter ranges have been mapped for more than 200 species and migration maps for a large number.

Among the more recent publications issued are: Biological Survey Bulletin 45, "Distribution and Migration of North American Herons and Their Allies"; Department Bulletins—128, "Distribution and Migration of North American Rails and Their Allies"; 185, "Bird Migration"; 187, "Preliminary Census of Birds of the United States"; and 292, "Distribution and Migration of North American Gulls and Their Allies"; Department Yearbooks—1903, "Some New Facts about the Migration of Birds"; 1910, "The Migratory Movement of Birds in Relation to the Weather"; and 1914, "Our Shorebirds and Their Future"; and Biological Survey Circular 84, "Distribution of American Egrets." In preparation: "Distribution and Migration of North American Terns and Their Allies," completed; "Distribution and Migration of North American Grebes, Loons, and Auks," nearly completed; Biological Survey Bulletin 26, "Distribution and Migration of North American Ducks, Geese, and Swans," revised edition with distribution maps completed; "Second Census of Birds of the United States," completed.

Assignment.—E. W. Nelson, H. C. Oberholser.

Proposed expenditures, 1916-17.—\$3,750.

Total, Biological Investigations, \$31,140, including \$4,640 statutory.

ENFORCEMENT OF THE MIGRATORY-BIRD LAW.**Supervision:**

Object.—To supervise, direct, and control the office and field activities in connection with the administration of the migratory-bird law.

Cooperation.—Associations and individuals interested in the conservation of wild life.

Location.—Washington, D. C.

Date begun.—1913.

Assignment.—George A. Lawyer.

Proposed expenditures, 1916-17.—\$9,575 (regulation, \$9,175; research, \$400).

[Regulation.]

Protection of Migratory Birds:

Object.—The protection of migratory game and insectivorous birds under the terms of the act of Congress approved March 4, 1913, and the regulations issued thereunder by the Department of Agriculture.

Procedure.—The United States is divided into 13 districts, under the supervision of 16 inspectors. Investigations are made of violations of the migratory-bird law, evidence is secured and submitted to the Solicitor of the department for transmission to the Department of Justice for prosecution. Valuable information is gathered and disseminated, whereby the public is educated as to the objects and necessity of the law for the protection of migratory birds. Cooperation is maintained between the bureau and the game departments of the several States in the protection of migratory birds and data secured to enable the bureau to administer the law intelligently. The administration will be continued along the lines already begun. By a campaign of education efforts are made to interest the people at large and to demonstrate to sportsmen and gunners the necessity for the proper observance of the regulations under the migratory-bird law.

Protection of Migratory Birds—Continued.

Cooperation.—Solicitor of the department, game departments of the several States, game protective associations, Audubon societies, and individuals throughout the United States.

Location.—Washington, D. C., and the several States. Headquarters of inspectors are as follows: Los Angeles, Cal., Fort Myers, Fla., Hinsdale and Mount Pulaski, Ill., Dubuque, Iowa., Atchison, Kans., Russellville, Ky., New Orleans, La., Owego and New York, N. Y., Manteo, N. C., Portland, Oreg., Providence, R. I., Ritter, S. C., Locustville and Newport News, Va., and Eau Claire, Wis.

Date begun.—1913.

Results.—Organization of the United States into 13 districts under 16 inspectors, 196 Federal wardens, and 5 game protectors; effective cooperation with most of the State game departments; 539 cases of violations reported and prepared for prosecution. As a result of the abolition of spring shooting and the protection afforded through the enforcement of the regulations, there has been a gratifying increase of all species of migratory birds. Birds that have heretofore been forced to Canada and the extreme North by continual shooting have, under the protection afforded, become comparatively tame and are again nesting within our borders.

Assignment.—George A. Lawyer.

Proposed expenditures, 1916-17.—\$39,625.

[Research.]

Investigation of Migratory Wild Fowl:

Object.—To secure information concerning the distribution and abundance of the migratory wild fowl in their breeding and wintering resorts, for the purpose of obtaining data concerning the increase or decrease of the species as a basis for changes in the regulations under the migratory-bird law. This inquiry will show the effect of the migratory-bird law in the conservation of wild fowl and will give needed information concerning the locations where they congregate during the breeding and winter seasons. As a result of this work it will be possible, when advisable, to locate areas which should be set aside as preserves in order to help conserve the species. It will also be possible to facilitate measures for increasing the species by safeguarding and possibly increasing their food supply.

Procedure.—Skilled field naturalists familiar with the species will be sent to make a careful survey of the breeding and wintering resorts of the wild fowl. They will approximately determine the absolute as well as the relative numbers of the species in each locality and definitely locate the areas where the largest number of birds congregate during the different seasons. Full reports will be made with maps. Later reports will be prepared for publication covering various areas, in order that the information procured may be available for the public.

Cooperation.—State game organizations, sportsmen's clubs, and individuals.

Location.—Washington, D. C., and many scattered areas throughout the United States, Canada, and Mexico.

Date begun.—1915.

Results.—Much information has been obtained from several localities, particularly in Nebraska and South Carolina, concerning the abundance and occurrence of wild fowl with reference to the influence of the migratory-bird law. A report on the wild fowl of Nebraska is practically ready for publication.

Assignment.—E. W. Nelson.

Proposed expenditures, 1916-17.—\$2,000.

Total, Enforcement of the Migratory-Bird Law, \$52,400, including \$2,400 statutory (regulation, \$48,800; research, \$2,400).

DIVISION OF PUBLICATIONS.

PUBLICATION WORK OF THE DEPARTMENT OF AGRICULTURE.

Supervision:

Object.—To supervise the printing, binding, and publication work of the department, including the editing, indexing, illustrating, and distribution of publications, and the photographic and motion-picture work; and to administer the expenditure of the general printing fund of the department.

Cooperation.—All branches of the department and the Government Printing Office.

Location.—Washington, D. C.

Date begun.—1890.

Assignment.—Jos. A. Arnold, B. D. Stallings, A. I. Mudd.

Proposed expenditures, 1916-17.—\$22,660. In addition, the division administers the general fund of \$600,000 appropriated to the Public Printer under the sundry civil act for printing and binding in the Department of Agriculture.

Editorial Work:

Object.—To edit and prepare for printing all manuscripts approved for publication, revise and correct proofs of the same, and prepare forms and blanks for the job work of the department.

Location.—Washington D. C.

Date begun.—1890.

Assignment.—B. D. Stallings.

Proposed expenditures, 1916-17.—\$19,970.

Indexing:

Object.—To prepare indexes to publications and to card-index, by subjects, all publications issued by the department.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—C. H. Greathouse.

Proposed expenditures, 1916-17.—\$11,030.

Illustrations:

Object.—To prepare drawings and photographs for use in illustrating publications of the department, for official records, and for lectures; and to make lantern slides for official use and furnish them, as well as photographs, to applicants at the price authorized by law. The work includes the making of motion pictures of the department's activities for educational purposes.

Location.—Washington, D. C.

Date begun.—1894.

Assignment.—A. B. Boettcher.

Proposed expenditures, 1916-17.—\$36,470.

Distribution of Documents:

Object.—To cooperate with the Government Printing Office in the distribution of department publications; to duplicate and distribute circulars of information, circular letters, and blank forms; and to maintain special and general lists of addresses to which department publications are mailed.

Cooperation.—Government Printing Office.

Location.—Washington, D. C.

Date begun.—1896.

Assignment.—F. J. P. Cleary.

Proposed expenditures, 1916-17.—\$107,520.

Total, Publication Work of the Department of Agriculture, \$197,650, including \$177,400 statutory. In addition, \$500,000 is appropriated under the sundry-civil act as a general printing fund for the department.

BUREAU OF CROP ESTIMATES.

GENERAL ADMINISTRATION.

Office of the Chief:

Object.—The direction of the business and other activities of the Bureau of Crop Estimates.

Procedure.—The work of the bureau in Washington is conducted under the direct supervision of the officials in charge. A bureau council, comprising the various supervising and administrative officials, meets monthly with the chief of bureau for report of progress and discussion of methods, difficulties, etc., concerning the work in hand. The supervision of the field force is accomplished through correspondence and regular trips of inspection by one of the bureau officials.

Cooperation.—Various bureaus and departments and the crop-reporting offices of some State governments.

Location.—Washington, D. C.

Date begun.—1866.

Assignment.—Leon M. Estabrook, Nat C. Murray.

Proposed expenditures, 1916-17.—\$12,264.

Office of the Chief Clerk:

Object.—General supervision of clerks and other employees; immediate supervision of the bureau's correspondence files, business records, and general accounts; purchase, custody, and distribution of supplies and property; distribution of seeds and publications to voluntary crop reporters.

Location.—Washington, D. C.

Assignment.—H. B. Cramer.

Proposed expenditures, 1916-17.—\$15,400.

Total, General Administration, \$27,664, including \$23,400 statutory (service, \$23,712; research, \$3,952).

[Service.]

CROP REPORTING AND ESTIMATING.

General Crops and Live Stock:

Object.—To collect, through correspondence and field investigation, information regarding crops and live stock, and to make public timely estimates or forecasts of acreage, condition, production, and values of crops, and numbers, condition, and values of live stock, and information closely related thereto.

Procedure.—Data are collected, in triplicate (with few exceptions), (a) from voluntary township reporters, each reporting for his immediate locality, (b) from voluntary county reporters, each reporting for his county, and (c) from salaried field agents, each reporting for an entire State. Information is collected monthly on schedules of inquiry. Reports from township and county reporters are each compiled into State averages by a large force of clerks in Washington. Special lists of correspondents are maintained and utilized for special investigation. A crop-reporting board, consisting of the chief of bureau and several assistants, reviews the State averages, derived from the three distinct sources mentioned, for the main crops, and determines the final estimates adopted by the bureau.

Cooperation.—Various bureaus and State and local organizations.

Location.—Headquarters at Washington, D. C. Each field agent has a station in the State to which he is assigned.

Date begun.—1866.

Results.—Monthly seasonable estimates by States and for the United States are made as follows:

Acreage—Total: Corn, winter wheat, spring wheat, oats, barley, rye, buckwheat, potatoes, sweet potatoes, tobacco, flax, rice, hay (tame), hay (wild), cotton, clover hay, sugar beets, beans, cranberries, and sorghum for sirup. Percentage of previous year's acreage: Clover seed and sugar cane.

General Crops and Live Stock—Continued.

Condition—Expressed in percentage of normal, with comparisons: Corn, winter wheat, spring wheat, oats, barley, rye, buckwheat, potatoes, sweet potatoes, tobacco, flax, rice, cotton, hay (tame), all hay, alfalfa hay, clover hay, clover seed, millet, timothy hay, meadows, pasture, bluegrass for seed, field peas, grain sorghum, apples, peaches, pears, grapes, apricots, blackberries, raspberries, cantaloupes, cranberries, grapefruit, lemons, limes, olives, oranges, pineapples, prunes, strawberries, watermelons, field beans, lima beans, cabbage, cauliflower, celery, onions, tomatoes, almonds, broom corn, hemp, hops, peanuts, sorghum for sirup, sugar beets, sugar cane, walnuts, horses and mules, cattle, sheep, swine, and honeybees.

Forecasts of production, based upon condition estimates, of corn, winter wheat, spring wheat, oats, barley, rye, buckwheat, potatoes, sweet potatoes, tobacco, flax, rice, hay (tame), cotton, apples, peaches, pears, and sorghum for sirup.

Yield per acre of corn, winter wheat, spring wheat, oats, barley, rye, buckwheat, potatoes, sweet potatoes, tobacco, flax, rice, cotton, hay (tame), hay (wild), clover hay, clover seed, alfalfa seed, grain sorghum, cranberries, grapefruit, lemons, oranges, cabbage, onions, beans (dry), broom corn, hemp, hops, peanuts, sorghum sirup, and sugar beets.

Production (quantitative)—Corn, winter wheat, spring wheat, oats, barley, rye, buckwheat, potatoes, sweet potatoes, tobacco, flax, rice, cotton, hay (tame), hay (wild), apples, peaches, pears, beans (dry), cranberries, sorghum sirup, sugar beets, timothy, clover, alfalfa, millet, and wool.

Production expressed in percentage of a full crop—Alfalfa hay, alfalfa seed, bluegrass seed, field peas (grain), field peas (forage), clover hay, clover seed, grain sorghum, millet hay, millet seed, timothy hay, apples, apricots, blackberries, raspberries, cantaloupes, cranberries, grapefruit, grapes, lemons, limes, olives, oranges, peaches, pears, pineapples, prunes, strawberries, watermelons, field beans (grain), field beans (forage), lima beans, cabbage, cauliflower, celery, onions, tomatoes, almonds, broom corn, hemp, peanuts, sugar beets, sugar cane, and walnuts.

Prices, monthly or in season—Corn, wheat, oats, barley, rye, buckwheat, potatoes, sweet potatoes, flax, hay (all), cotton, apples, peaches, pears, grapes, peanuts, tomatoes, cabbage, onions, broom corn, timothy hay, clover hay, alfalfa hay, prairie hay, clover seed, alfalfa seed, grapefruit, lemons, limes, oranges, pineapples, hops, honey, butter, eggs, cotton seed, cottonseed meal, bran, milk, maple sugar, maple sirup, wool, walnuts, hickory nuts, pecans, chestnuts, soy beans, dry beans, timothy seed, cowpeas, popcorn, turnips, cottonseed hulls, kafir corn, tobacco, rice (December only), hogs, beef cattle, veal calves, sheep, lambs, horses, milch cows, chickens, and turkeys.

Quality—Corn, winter wheat, spring wheat, oats, barley, rye, buckwheat, potatoes, sweet potatoes, tobacco, flax, rice, hay (tame), hay (wild), clover hay, apples, cranberries, grapefruit, grapes, lemons, limes, oranges, peaches, pears, hops, and peanuts.

Stocks on farms, on certain dates—Corn, wheat, oats, barley, hay, and potatoes.

Quantity shipped out of county where grown—Corn, wheat, oats, barley, and apples.

Numbers—Total: Horses, mules, milch cows, other cattle, sheep, and swine. **Percentage of preceding year:** Stock hogs, breeding sows, and honeybees (colonies).

Losses during year from disease or exposure: Horses and mules, cattle, sheep, lambs, and swine.

Weight per unit of measure—Wheat, oats, barley, and wool.

In addition to data regularly collected relating to crops and live stock as stated above, special investigations through the corps of correspondents are occasionally made, usually by request of other bureaus, and yearly investigations are made into the following subjects: Wages of farm labor; values of farm lands; plowing and planting done by May 1; dates of planting and harvesting; maximum yields; causes of crop damage; monthly farm movement of grain and cotton; prices of articles purchased by farmers.

Results are given to the public mostly through press reports in the "Monthly Crop Report," a serial publication for free distribution, and in the Yearbook of the Department of Agriculture.

Assignment.—Leon M. Estabrook, Nat C. Murray, S. A. Jones, Edward Crane.

Proposed expenditures, 1916-17.—\$220,520.

- (**Crop Areas:** Discontinued as a separate project; included under "General Crops and Live Stock.")
- (**Crop Conditions and Forecasts:** Discontinued as a separate project; included under "General Crops and Live Stock.")
- (**Crop Production and Stocks:** Discontinued as a separate project; included under "General Crops and Live Stock.")
- (**Farm Prices and Values:** Discontinued as a separate project; included under "General Crops and Live Stock.")
- (**Crop Damage:** Discontinued as a separate project; included under "General Crops and Live Stock.")
- (**Farm Wages:** Discontinued as a separate project; included under "General Crops and Live Stock.")
- (**Dates of Planting and Harvesting:** Discontinued as a separate project; included under "General Crops and Live Stock.")
- (**Live Stock:** Discontinued as a separate project; included under "General Crops and Live Stock.")
- (**Honeybees:** Discontinued as a separate project; included under "General Crops and Live Stock.")

The foregoing nine projects are so closely interrelated that they should be considered as factors in one large activity rather than separate lines of work. (a) It has not been found practicable to treat them separately and segregate the time and expense involved in connection with each; (b) the work on them is carried on simultaneously.

Truck Crops:

Object.—To collect and publish information relating to the status of the truck-crop industry in the important truck-crop districts of the United States.

Procedure.—Special lists of truck-crop growers are maintained, to which are sent schedules of inquiry calling for the information desired for publication; also personal investigations and inspections are made by two truck-crop specialists, with headquarters in the field, and one truck-crop specialist in charge, whose headquarters are in Washington, D. C.

Cooperation.—Office of Markets and Rural Organization.

Location.—Washington, D. C., and in the field.

Date begun.—1914.

Results.—Estimates of acreage of early potatoes, cabbages, onions, cantaloupes, watermelons, strawberries, tomatoes, and lettuce, and of production of onions and cabbages are made in season for important districts. The condition of 16 truck crops are reported monthly. Estimates of acreage of corn, peas, tomatoes, snap beans, cucumbers, and cabbage consumed by canneries and pickling works are made yearly.

Assignment.—F. J. Blair, Edward Crane.

Proposed expenditures, 1916-17.—\$23,236.

Total, Crop Reporting and Estimating, \$243,756, including \$64,080 statutory.

[Research.]

CROP RECORDING AND ABSTRACTING.

Recording United States and Foreign Crop Statistics:

Object.—To collect, from published and unpublished records, statistical data relative to agriculture in the United States and foreign countries, and to make such data available for study and practical use.

Procedure.—Reports are secured from official, and authoritative private, sources in the United States and foreign countries; and the desired data are reviewed, recorded, summarized, and interpreted, under the direction of statistical scientists. A statistical library is maintained in connection with this work. Reports as to acreage and production of sugar crops are made, each by means of an enumeration or census, the data being obtained from sugar makers.

Cooperation.—Department library, International Institute of Agriculture, various branches of this and other Federal departments; also various State officials, commercial organizations, and other agencies.

Location.—Washington, D. C.

Recording United States and Foreign Crop Statistics—Continued.

Date begun.—1866.

Results.—Manuscript records of United States and foreign crops, wholesale prices, and miscellaneous agricultural statistics are kept and are used as a basis for giving information (a) in response to numerous special requests and (b) in publications.

Special requests for crop data, both orally and by correspondence, are received at the rate of several thousand a year; replies are made from office records or from special investigations.

The department Yearbook's statistical tables are prepared under the project "Crop Recording and Abstracting" (118 tables in 1915) and partly under "Crop Reporting and Estimating" (84 tables in 1915).

The sugar reports include (1) area of sugar beets planted (July); (2) preliminary report on production of beet sugar, and area and production of sugar beets (December); (3) final report on beet sugar and sugar beets (about April); (4) preliminary estimate of cane to be used for sugar in Louisiana (December); (5) final report of sugar and cane in Louisiana (about March); and (6) production of sugar and area and production of cane in Hawaii (about March).

Bulletins on special subjects relating to agricultural estimates and statistics are in preparation, as follows: (a) Meat supply in the United States and foreign countries (G. K. Holmes); (b) fruit production and supply in the principal countries (H. D. Ruddiman); (c) sugar production and supply in the principal countries (Perry Elliott); (d) geographical phases of farm prices in the United States (L. B. Zapoléon); and (e) surplus and deficiency of the agriculture of the United States (G. K. Holmes).

Reports to the International Institute of Agriculture are made monthly, by mail and by cable, and cabled reports from the institute are received and transmitted to the press.

The bureau library maintains (a) files of annual reports on crops, live stock, prices, trade movements, etc., issued by the United States, individual States, commercial organizations, private concerns, and by most of the foreign governments; (b) a large collection of monthly, weekly, and daily periodicals, reports, and circulars; and (c) special publications relating to agricultural statistics.

Assignment.—Frank Andrews, G. K. Holmes, C. M. Daugherty, Perry Elliott, H. D. Ruddiman.

Proposed expenditures, 1916-17.—\$45,016, including \$35,400 statutory.

- (**United States and Foreign Crop Data:** Discontinued as a separate project; included under "Recording United States and Foreign Crop Statistics.")
- (**International Trade in Agricultural Products:** Discontinued as a separate project; included under "Recording United States and Foreign Crop Statistics.")
- (**Chronology of Agriculture:** Discontinued as a separate project; included under "Recording United States and Foreign Crop Statistics.")
- (**Geographical Phases of Farm Prices:** Discontinued as a separate project; included under "Recording United States and Foreign Crop Statistics.")
- (**Fruits and Nuts of Foreign Countries:** Discontinued as a separate project; included under "Recording United States and Foreign Crop Statistics.")
- (**Agricultural Elements of Population:** Project completed; published in part.)
- (**International Sugar Investigations:** Discontinued as a separate project; included under "Recording United States and Foreign Crop Statistics.")
- (**United States Exports and Imports of Farm and Forest Products:** Project completed; publication issued.)
- (**Surplus and Deficiency of National Agricultural Products:** Discontinued as a separate project; included under "Recording United States and Foreign Crop Statistics.")

ALLOTMENT OF BUREAU OF CROP ESTIMATES APPROPRIATIONS BY PROJECTS.

Project.	Statutory salaries.	General expenses.			Total.
		Adminis- trative expenses.	Field investi- gations.	Total.	
General administration:					
Office of chief.....	\$9,000	\$3,264		\$3,264	\$12,264
Office of chief clerk.....	14,400	1,000		1,000	15,400
Crop reporting and estimating:					
General crops and live stock.....	56,380	6,500	\$157,640	164,140	220,520
Truck-crop investigations.....	7,700	4,320	11,216	15,536	23,236
Crop recording and abstracting:					
Recording United States and foreign statistics	35,400	9,616		9,616	45,016
Total.....	122,880	24,700	168,856	193,556	316,436

STATES RELATIONS SERVICE.

GENERAL ADMINISTRATION.

Office of Director:

Object.—General administration of the affairs of the States Relations Service.

Cooperation.—Other offices of the department, other departments, and State agricultural colleges and experiment stations.

Location.—Washington, D. C.

Date begun.—1888, as Office of Experiment Stations; 1915, under present organization.

Assignment.—A. C. True.

Proposed expenditures, 1916-17.—\$6,284.

Office of Chief Clerk:

Object.—To supervise the clerical and subclerical force of bureau; handle all matters relating to appointments and leaves of absence; supervise central file room and property room; handle mail and review all correspondence for the director.

Cooperation.—Other offices of the department and other departments.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—Carrie E. Johnston.

Proposed expenditures, 1916-17.—\$20,136.

Accounts:

Object.—The systematic administration of the fiscal affairs of the bureau.

Cooperation.—Office of Inspection, Disbursing Office, and the Treasury Department.

Location.—Washington, D. C.

Date begun.—1906.

Assignment.—F. E. Singleton.

Proposed expenditures, 1916-17.—\$15,050.

Editorial Work:

Object.—To edit and prepare for printing manuscripts and proofs of articles submitted for publication by members of the service, to cooperate with the Division of Publications in maintaining mailing lists and in the distribution of publications of the service, and to have charge of lantern slides and other illustrative material and job printing.

Cooperation.—Division of Publications and other branches of the department.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—W. H. Beal.

Proposed expenditures, 1916-17.—\$15,940.

Library:

Object.—To collect and care for the publications of the agricultural experiment stations and the agricultural extension services; circulate and care for books and periodicals in the States Relation Service; examine domestic and foreign literature of agricultural science with reference to matters for use in the Experiment Station Record and to assign this to the editors of that journal; and perform reference and bibliographical work for the several offices of the service.

Cooperation.—Main department library; Library of Congress, and libraries of the State agricultural colleges and experiment stations.

Location.—Washington, D. C.

Date begun.—1888.

Assignment.—Eloise L. Ogden.

Proposed expenditures, 1916-17.—\$3,110.

Total, General Administration, \$60,520, including \$44,240 statutory (extension, \$49,195; research, \$8,325; regulation, \$3,000).

RELATIONS WITH EXPERIMENT STATIONS.

[Regulation.]

STATE EXPERIMENT STATIONS.

State Experiment Stations:

Object.—To enforce the provisions of an act approved March 2, 1887, and acts supplementary thereto, and of an act approved March 16, 1906, creating and endowing agricultural experiment stations; to enable the Secretary of Agriculture to certify to the Treasury Department whether Federal funds may properly be advanced to the State experiment stations and to report to Congress regarding the work and expenditures of these institutions; to furnish prompt information regarding the organization, equipment, resources, and work of experiment stations and kindred institutions throughout the world to workers in similar lines in this department and the agricultural colleges, schools, and experiment stations; and to aid the State experiment stations in the effective development of their work.

Procedure.—A financial report on schedules approved by the Secretary of Agriculture is received from each station and examined and approved in this office. Written and printed reports of the work and expenditures of each station are received and examined. A personal inspection of the work, account books, and vouchers of each station is made annually. On the basis of the information gained from the aforesaid sources a report on the work and expenditures of each station is annually made to Congress and distributed in this and other countries. The plans for work under the act of Congress of March 16, 1906, are reported by each station to this office and approved here in advance of their execution. The publications of agricultural institutions throughout the world are abstracted in a journal entitled "Experiment Station Record," issued in two volumes of nine numbers each and a detailed index each year. Advice and information regarding the stations are also given, in large measure by correspondence and personal conference with station officers.

Cooperation.—The bureaus of this and other departments, the State experiment stations, and agricultural institutions in many countries.

Location.—Washington, D. C.

Date begun.—1893.

Results.—More careful and effective expenditure of funds granted to the experiment stations; department, station, college, and school workers regularly kept informed regarding the progress of agricultural research, and thus enabled to plan and execute their work more effectively and with less waste of effort and funds.

Assignment.—E. W. Allen.

Proposed expenditures, 1916-17.—\$47,376, including \$11,120 statutory.

[Research.]

INSULAR EXPERIMENT STATIONS.

Supervision:

Object.—To exercise general supervision over the work of the experiment stations in Alaska, Hawaii, Porto Rico, and Guam.

Procedure.—The plans of work and expenditures of all stations are annually reported in advance to the Washington office for approval. The vouchers recording their expenditures are examined and approved here. Their annual reports and bulletins are submitted to this office for review and approval before publication. By correspondence and occasional personal inspection, close touch with the progress of the stations is maintained.

Cooperation.—The bureaus of this and other departments.

Location.—Washington, D. C.

Date begun.—1902.

Assignment.—W. H. Evans.

Proposed expenditures, 1916-17.—\$3,204.

Alaska Experiment Stations:

Object.—Development of agriculture, horticulture, and stock raising in Alaska.

Procedure.—This work is accomplished through agricultural surveys, the establishment and maintenance of experiment stations, and cooperative investigations to determine the agricultural possibilities of Alaska and to aid in the development and improve the character of the agriculture in this Territory. Informa-

Alaska Experiment Stations—Continued.

tion regarding the results of the investigations is disseminated by means of bulletins, reports, and correspondence, and through demonstration work.

Cooperation.—The bureaus of this and other departments, experiment stations in various States and foreign countries, individuals, etc.

Location.—Headquarters, Sitka, Alaska; branch stations at Rampart, Fairbanks, and Kodiak.

Date begun.—1898.

Results.—The investigations are showing what varieties of agricultural and horticultural plants are best adapted to different regions. Plant-breeding experiments have already developed some new and hardy varieties of cereals, berries, etc. Soil studies are showing the proper methods of handling the soil. Experiments on Kodiak Island have demonstrated methods for the renewal of plant growth after the volcanic eruption of 1912. Experiments with live stock are showing the possibility of stock raising along the coast region, depending wholly on native forage. Circular 1 of the Alaska stations, "Information for Prospective Settlers in Alaska," has been issued, and the annual report for 1915 has been prepared and submitted for publication.

Assignment.—C. C. Georgeson, J. W. Neal, M. D. Snodgrass, G. W. Gasser.

Proposed expenditures, 1916-17.—\$48,000.

Hawaii Experiment Station:

Object.—To investigate the underlying principles of agriculture in Hawaii and to apply this knowledge to the diversification of agriculture in those islands.

Procedure.—Experiments are conducted with tropical crops to determine their adaptability to Hawaiian conditions, including the introduction of new and promising varieties of agricultural plants, forage production, plant-breeding work, study of the peculiar soils of Hawaii to determine proper methods of management, investigations of insects and other pests looking to methods of control, work in cooperative dairying, etc. The results are given publicity in bulletins and reports, correspondence, and through demonstration work.

Cooperation.—The bureaus of this department, the War Department, private individuals, and the territorial government of Hawaii.

Location.—Headquarters, Honolulu; branch stations on other principal islands.

Date begun.—1901.

Results.—A survey has been completed of the forage plants of the islands with a view to range improvement. Better methods of soil management for the utilization of nitrogen in soils have been worked out. The effect of different fertilizers on Hawaiian soils has been determined, and a survey of some of the principal soil types has been concluded.

The investigations have shown the possibility of diversification of agriculture, proper methods of soil management, fertilizers for rice and pineapples, the value of rotations and cover crops, possibilities of new agricultural industries, methods of range improvement, methods of pest control, practicability of cooperative marketing and dairying, utilization of certain by-products, etc. A considerable number of new forage plants have been introduced and widely disseminated. New agricultural and horticultural crops have been found adapted to Hawaiian conditions, and improved strains have been developed. Soil surveys have been made, and demonstration work is organized on all the larger islands. Publications issued: Bulletin 39 of the Hawaii Experiment Station, "The Biochemical Decomposition of Nitrogenous Substances in Soils." Manuscripts on the following subjects have been prepared and submitted for publication: "The Soils of the Hawaiian Islands," "Phosphate Fertilizers for Hawaiian Soils and Their Availability," "The Composition of Hawaiian Soil Particles," and the annual report for 1915.

Assignment.—J. M. Westgate, J. F. Higgins, F. G. Krauss, M. O. Johnson, J. B. Thompson, C. A. Sahr, A. T. Longley.

Proposed expenditures, 1916-17.—\$40,000.

Porto Rico Experiment Station:

Object.—To investigate the underlying principles of agriculture in Porto Rico and to apply this knowledge to the improvement of agricultural practices in that island.

Procedure.—Experiments are conducted with various tropical crops to determine their adaptability, including the introduction of new and improved varieties of agricultural and horticultural plants, work in plant breeding, studies in soil management, investigations on the control of insects and fungous pests, work in animal husbandry, and beekeeping. The results are given publicity by means of bulletins, reports, correspondence, extension work, and demonstrations.

Porto Rico Experiment Station—Continued.

Cooperation.—The bureaus of this department, the insular government, individuals, and corporations.

Location.—Headquarters, Mayaguez, P. R.; cooperative work at many places on the island.

Date begun.—1901.

Results.—Investigations have shown the inadaptability of certain types of soil to coffee planting. The value of cover crops for citrus orchards and other plantations has been demonstrated. As a result of experiments it has been found that varieties of vegetables do not deteriorate in the tropics but that serious losses occur through diminished vitality of seed and planting in the wrong season. A method whereby the vitality of seed may be prolonged has been worked out under Porto Rican conditions.

Better methods of handling some of the peculiar soils have been discovered, improved varieties of coffee introduced, improvements in stock breeding and care brought about, the proper fertilizers for citrus orchards determined, the value of rotations and cover crops shown, beekeeping as an industry of the island established, some work on sanitary dairying begun, and many new and improved agricultural and horticultural crops introduced. Bulletin 19 of the Porto Rico Station, "Cover Crops for Porto Rico," has been published, and manuscripts on the following subjects have been prepared and submitted for publication: "Place-Effect Experiments with Vegetables in Porto Rico," "Some Unprofitable Coffee Lands," and the annual report for 1915.

Assignment.—D. W. May, P. L. Gile, C. F. Kinman, R. H. Van Zwaluwenburg, E. W. Brandes, T. B. McClelland.

Proposed expenditures, 1916-17.—\$40,000.

Guam Experiment Station:

Object.—Determination of agricultural possibilities and improvement of agricultural practices in Guam.

Procedure.—Through a study of the agricultural and allied industries of Guam and the introduction and trial of crops and animals from other countries, the station is making an attempt to restore and improve the agriculture of the island. The results of the investigations are given in publications and are shown in demonstration experiments.

Cooperation.—The bureaus of this department and the island government.

Location.—Island of Guam.

Date begun.—1908.

Results.—The successful introduction of Egyptian cotton in 1915 seems to assure a new industry to the island.

Through the introduction and establishment of various forage plants permanent supplies of forage are made possible, and the improvement of the live stock of the island has been begun. Improved breeds of horses, cattle, goats, swine, and poultry have been introduced, acclimated, and are being used to build up better live stock. Some of the agricultural and horticultural crops brought from other countries have proved superior to varieties now grown on the island and are well received by the people. Studies are in progress on animal diseases peculiar to the tropics with results that promise to be of value. The report of this station for the fiscal year 1915 has been submitted for publication.

Assignment.—A. C. Hartenbower, L. B. Barber, P. Nelson.

Proposed expenditures, 1916-17.—\$15,000.

Total, Insular Experiment Stations, \$146,204, including \$960 statutory.

Total, Relations with Experiment Stations, \$193,580, including \$12,080 statutory (research, \$146,204; regulation, \$47,376).

[Regulation.]

RELATIONS WITH EXTENSION DIVISIONS OF STATE AGRICULTURAL COLLEGES.**Relations with Extension Divisions of State Agricultural Colleges:**

Object.—To enforce the provisions of the act approved May 8, 1914, providing for cooperative agricultural extension work; to enable the Secretary of Agriculture to certify to the Treasury Department whether Federal funds may properly be advanced to the State agricultural colleges, and to report to Congress regarding

Relations with Extension Divisions of State Agricultural Colleges—Cont'd.

the work and expenditures of the extension divisions of these institutions; and to coordinate the work of the department with the State agricultural colleges in the lines authorized in said act.

Procedure.—A financial report on schedules approved by the Secretary of Agriculture is received from each extension division and examined and approved in this office. Written and printed reports of the work and expenditures of each extension division are received and examined. A personal inspection of the work, account books, and vouchers of each division is made annually. On the basis of the information gained from the aforesaid sources a report on the work and expenditures of each extension division is annually made to Congress and distributed in this and other countries. The plans for work under the act of May 8, 1914, are reported by each extension division to this office and approved here in advance of their execution. Projects involving cooperative extension work between the bureaus of the Department of Agriculture and the State agricultural colleges are also considered and approved in this office.

Cooperation.—State agricultural colleges in 48 States.

Location.—Washington, D. C.

Date begun.—1914.

Assignment.—Bradford Knapp, J. A. Evans, W. D. Bentley, H. E. Savely, W. B. Mercier, C. B. Smith, L. A. Clinton, D. W. Working, A. B. Graham.

Proposed expenditures, 1916-17.—\$25,440, including \$5,440 statutory.

[Extension.]

FARMERS' COOPERATIVE DEMONSTRATIONS IN THE SOUTHERN STATES.**Supervision:**

Object.—To carry on supervisory, clerical, and routine work necessary to properly conduct the demonstration work in the Southern States.

Cooperation.—Other bureaus of the department, State agricultural colleges, counties, and county organizations.

Location.—Washington, D. C.

Date begun.—1904.

Assignment.—Bradford Knapp, J. A. Evans.

Proposed expenditures, 1916-17.—\$43,385.

County-Agent and Boys' Club Work:

Object.—To disseminate information from the Department of Agriculture and the agricultural colleges on subjects relating to agriculture; to secure the adoption of the practices recommended by conducting demonstrations on farms; to organize a system of instruction through practical field demonstrations and otherwise by employing and directing the work of county agricultural agents or demonstration agents; to carry out information from the department collected by the research work of its several divisions, by establishing contact between the research divisions of the department and the cooperative extension work in the States through the States Relations Service, State directors of extension work, and State, district, and county agents engaged in demonstration work; to give instruction to boys through the organization and work of boys' clubs, such as corn clubs, pig clubs, potato clubs, etc.; and to assist in bringing to the State, district, and county agents, through the State extension officers, the best systems of conducting the county-agent work and the boys' club work. In this work is also included the teaching and demonstration of the best methods of meeting the ravages of the Mexican cotton boll weevil in all cotton territory.

Procedure.—In each State there is a director of extension work, who is a representative of the U. S. Department of Agriculture and the agricultural college of the State concerned. Under the terms of the project agreements with each State, he is made responsible to the department and to the college for the faithful administration of the work. Under him there is generally a State agent or leader, district agents, county agents, and also specialists. All the work is in cooperation with the State agricultural college in each State. The county agents organize and conduct general demonstration and extension work in their counties. The main feature of their work is the conducting of a large number of actual demonstrations along various agricultural lines on the farms in the county in cooperation with farmers, which are made object lessons for the teaching of better agricultural practices to these farmers and their neighbors. County agents also give miscellaneous information to farmers on all agricultural subjects upon application, conduct meetings and field schools at the demonstra-

County-Agent and Boys' Club Work—Continued.

tions, and organize and conduct such meetings, institutes, or short courses as may be necessary for the further extension of their work. They also foster the development of community organizations for the purpose of receiving instruction, through demonstrations and otherwise, and endeavor in every way to build up and organize a system of education outside the schools. Often the community organizations of the farmers and their families are federated together into some type of county organization. They are aided in their work of teaching, through demonstrations and otherwise, and in organization, by specialists from the agricultural colleges and from the department. They also organize, in cooperation with the schools, boys' agricultural clubs for various purposes and cooperate with specialists and others in their instruction. Extension divisions in the States and extension specialists are assisted in their work by specialists from the department, who furnish them with technical instruction obtained from research divisions of the department and with special information on methods of conducting demonstration and extension work through employees of the Office of Extension Work in the South of this bureau.

Cooperation.—State agricultural colleges, other State institutions, counties, and county organizations.

Location.—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

Date begun.—1904.

Results.—During the crop season of 1915 approximately 110,000 adult farmers carried out definite demonstration work on their own farms under the supervision of agents engaged in the demonstration work. Information, advice, and assistance were given to approximately ten times this number through field meetings, farmers' meetings, circular letters, and in other ways. Each farm demonstration serves as an object lesson for the community in which it is located and influences a considerable number of other farmers.

During the crop season of 1915 demonstrations embracing all farm crops included the following: 446,004 acres in corn demonstrations, 201,974 acres in cotton demonstrations, 2,630 acres in tobacco demonstrations, 196,000 acres in small-grain demonstrations, 152,745 acres in hay and forage-crop demonstrations, 265,177 acres of cover-crop demonstrations, 102,939 acres of summer-legume demonstrations, 7,476 acres in potato demonstrations, and 105,791 acres of old pastures renovated. Among the many miscellaneous results accomplished during the year 1915 may be mentioned the removal of stumps from 71,819 acres, the drainage of 221,596 acres, and the terracing of 202,705 acres to prevent erosion. There were 29,319 demonstrations in home gardens. The number of improved implements and tools bought at the suggestion of agents, for labor-saving purposes, was 64,079. Work was done with orchards involving 2,216,000 trees. The agents instructed farmers in the erection of 4,584 silos and 1,579 dipping vats, and 29,007 farmers were instructed in the care of manure, with an estimated saving of 3,381,030 tons. Agents instructed 110,570 farmers in the use of commercial fertilizers and advised farmers in 678 cooperative community organizations regarding the purchase of fertilizers, with a saving in cost to these communities of over \$125,000. They suggested and assisted in the organization of 1,654 community organizations of farmers for the study of local problems and the meeting of local business needs, with a membership of 44,548. The general results of demonstration work have been the widespread adoption of better methods, particularly in the preparation of the land, selection of seed, and cultivation of the crop. The demonstrations as a rule exceed the average production by 100 per cent. There has been continued interest in live stock, resulting in bringing into the territory 1,776 pure-bred horses and mares; 8,639 pure-bred high-grade dairy cattle; 12,560 pure-bred, high-grade beef cattle; 17,739 pure-bred hogs; and 9,568 head of pure-bred, high-grade sheep and goats. Demonstrations have been conducted with 109,208 head of poultry. The agents secured the treatment of 1,729,177 head of live stock for various animal diseases and pests. Agents made 612,225 visits to farms, traveling 3,046,577 miles. They were called upon 203,617 times at their offices or homes for information; held 16,010 field meetings and addressed 16,667 meetings, with a total attendance of 1,217,113; held 5,811 field meetings at demonstrations, with an attendance of 112,668; distributed 1,283,230 bulletins of the department, the agricultural colleges, and experiment stations; 473 extension schools or short courses were held in their counties, with an attendance of 75,334. There was a total of 62,922 boys enrolled in the corn clubs, with an

County-Agent and Boys' Club Work—Continued.

average production of 51.37 bushels per acre, as shown by the returns of those who reported. The field work is carried on by 27 directors and State agents, 22 assistant State agents and boys' club agents, 45 district agents, 737 county agents, and 73 special agents.

Assignment.—Bradford Knapp, J. A. Evans, W. B. Mercier, H. E. Savely, I. W. Hill.

Proposed expenditures, 1916-17.—\$560,375.

Home Demonstration Work, Including Girls' Club Work:

Object.—To organize and carry on extension work for women and girls by employing and directing the work of women county agents, for the purpose of disseminating information and conducting demonstrations with farm women in the homes in the rural sections of the South and instructing girls in home economics and kindred subjects; to carry out information from the U. S. Department of Agriculture and State colleges on subjects relating to home economics and allied subjects; also to disseminate information on methods of conducting home demonstration work and extension work for women to extension workers in the various States.

Procedure.—In cooperation with the various institutions in the South, women county agents are employed, part of whose salaries are paid by the counties and part from funds of the colleges and the department. They conduct demonstrations in home gardens and poultry, organize women's clubs for demonstration and study, and give general instruction in home economics; organize girls' clubs in the teaching of gardening and canning and other subjects, and carry on the general work of extension in home economics, and, in general, proceed with their work in practically the same manner as do the men county agents, the work of the women county agents and the work of the county agricultural agents being coordinated as closely as possible. In addition to specialists from the agricultural colleges, specialists from the U. S. Department of Agriculture will give assistance in the instruction of farm women and girls and in the training and instruction of extension workers in this division of the work.

Cooperation.—State agricultural colleges, women's colleges, and local organizations.

Location.—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

Date begun.—1911.

Results.—Demonstration work for girls and women began with the canning clubs in 1910, when four counties in two States were organized. In 1915 there were 368 counties with women county agents. They gave instruction to 32,613 girls and direct instruction to 6,871 women. Each of the girls produced a one-tenth acre home garden of tomatoes or tomatoes and other vegetables. They put up 2,166,515 cans of fruits and vegetables, estimated to be worth \$300,000. The average profit per member was \$24. Instruction was also given in the raising of poultry, marketing of eggs, making of butter, keeping of milk, preparation of food for the table, baking of bread, etc. In the girls' work the women county agents held 10,784 public meetings attended by 409,283 persons. In the poultry clubs there were enrolled 9,854 members, and 3,062 members in bread clubs. In the work for adult women special attention has been given to labor-saving devices, such as simple home water works, screening of houses, making of fireless cookers and iceless refrigerators, construction of wheel trays, fly traps, etc. There were 6,871 women demonstrators who did some line of work in their own homes in the way of home improvements, and 250 women's community clubs were organized. In the meetings held for the purpose of instruction there was an attendance of 74,335 women. In a number of counties in Texas, Mississippi, Oklahoma, Virginia, and Louisiana special effort was made to teach farm women to market eggs by organizing egg circles and cooperative egg-selling associations. These were very successful. The field work is carried on by 15 State home demonstration agents, 14 assistants, 7 district agents, and 405 county home demonstration agents.

Assignment.—Bradford Knapp, O. B. Martin, Mary E. Creswell, Ola Powell.

Proposed expenditures, 1916-17.—\$91,620.

Total, Farmers' Cooperative Demonstrations in the Southern States, \$695,380, including \$34,080 statutory.

[Extension.]

FARMERS' COOPERATIVE DEMONSTRATIONS IN THE NORTHERN AND WESTERN STATES.**Supervision:**

Object.—To carry on supervisory, clerical, and routine work necessary to properly conduct the demonstration work in the Northern and Western States.

Cooperation.—Other bureaus of the department.

Location.—Washington, D. C.

Date begun.—1912.

Assignment.—C. B. Smith, L. A. Clinton.

Proposed expenditures, 1916-17.—\$35,490.

County-Agent Work:

Object.—To give instruction and demonstrations in agriculture, in order to secure the adoption of better farm practice, organization, and administration, to the end of increasing the profits of farming and in improving social life.

Procedure.—In each State there is a director of extension work, who is the joint representative of the State agricultural college and the department and is in administrative control of all the cooperative agricultural extension work in the State. For the purposes of this project, under the director is a State leader of county agents, chosen under a cooperative agreement between the college and the department and representing both parties. Subject to the approval of the college and the department, the State leader enters into agreements with boards of county commissioners and local associations to finance and otherwise support the work of a county agricultural agent and to select a suitable agent, who works thereafter under the direct supervision of the State leader. The county agents, who are men well trained in the science of agriculture and familiar with farm practice, are located permanently in counties (with or without assistants) as rapidly as circumstances warrant and funds permit. They coordinate and apply the results of the work of the several departments of the State agricultural colleges and of the U. S. Department of Agriculture and other research institutions, as well as the results of their own local studies of farm practice, to the end of carrying concretely to the farmers, through demonstrations on their own farms, field meetings, the local press, and otherwise, a knowledge of sound principles and successful practices in agriculture. They also aid in the reorganization and redirection of the agriculture of the counties in which they work, their aim being the correlation and federation of all economic and social forces working for the improvement of agriculture and country life. As occasion offers or need arises, they cooperate with or organize agricultural societies, clubs, and other associations whose objects are the improvement of agricultural practices, marketing and purchasing methods and facilities, and educational, home, and social conditions throughout the counties in which they work. Farmers and members of their families are met individually for consultation and in groups for purposes of study, instruction, and demonstration in the school, creamery, barn, orchard, or field.

Cooperation.—State agricultural colleges and county organizations.

Location.—Throughout the 33 Northern and Western States.

Date begun.—1912.

Results.—Among the results accomplished during the past year are the following: 107,892 farmers were visited on their farms and given some definite assistance in matters relating to farm management or farm practice; 181,112 farmers called on the agent at his headquarters for advice concerning farm business; 29,789 meetings were addressed, attended by 1,732,272; the membership of the county farm bureaus cooperating in the work increased to 80,966; 120,310 farmers attended 1,046 short courses or extension schools; 736 observation parties were conducted to the homes of successful farmers for the purpose of inspecting improved methods of agricultural practice; 21,075 farmers selected seed corn in the fall under the direction of the agent, and 516,000 acres were planted with seed thus selected. In fields where yields were determined, an increase of 12.8 bushels per acre was shown for corn, 8.4 for wheat, and 11.07 for oats; 216,960 acres of wheat and 92,518 acres of alfalfa were sown in accordance with the agent's directions; 22,762 farmers treated their seed oats for smut, and 708,056 acres were sown with treated seed. The agents have also promoted the growing of 13,126 acres of sweet clover, 17,047 acres of soy beans, and 8,613 acres of cowpeas; 7,698 registered live stock were purchased on suggestion of agents; 143 cow-testing associations were organized; 8,113 animals were tested for tuberculosis; 34,851 were treated for blackleg, and 292,992 hogs

County-Agent Work—Continued.

were vaccinated for hog cholera by the agent or by veterinarians on his suggestion; 160,618 tons of limestone were used; 66,041 acres of leguminous crops were plowed under for green manure; 4,619 farmers were influenced to keep farm accounts; farmers' exchanges were organized which did a total business of \$341,110; 193 farms were rented through the exchanges, and 2,935 farmers were furnished with 5,488 laborers. The county agents assisted in the organization of 164 purchasing and marketing associations; the total amount of business done by business associations organized by the agents amounting to \$3,575,373, effecting an approximate saving of \$278,000. The number of agents working on January 1, 1915, was 276; on January 1, 1916, 368; thus making an increase of 92 agents for the year 1915.

Assignment.—W. A. Lloyd, H. B. Fuller, H. W. Gilbertson, L. R. Simons.

Proposed expenditures, 1916-17.—\$304,380.

(Demonstrations in the Eastern States: Discontinued as a separate project; included under "County-Agent Work.")

(Demonstrations in the Central States: Discontinued as a separate project; included under "County-Agent Work.")

(Demonstrations in the Western States: Discontinued as a separate project; included under "County-Agent Work.")

Boys' and Girls' Club Work:

Object.—To interest boys and girls and, through them, farm men and women in farm, farm-home, and rural-community problems; to teach them better methods of farm, garden, and home practice; to bring them in touch with the work of the department and the agricultural colleges and schools; and to encourage them in securing such an education as will aid in making them useful and successful workers, homemakers, and citizens.

Procedure.—The boys' and girls' club work is based upon the organization of a local group of young people who are to undertake a definite project, and this work contemplates definite enrollment of members; organizing them into a local club; furnishing them with follow-up instructions; making personal visits to their plats; holding field meetings for instructional purposes; keeping records of observations and crop reports; making exhibits of products; encouraging the study of improved methods of grading, crating, and marketing, and the use, through home canning, of the surplus or by-products; holding club fairs and play festivals; and giving suggestions as to how this club work may be correlated and coordinated with the activities not only of the home but of the public schools. The various club projects are corn, potato, home gardening and canning, mother-daughter home canning, alfalfa, poultry, market-garden, farm and home handicraft, forage, home-management, farm-management, sewing, and sugar-beet clubs. The club work is organized and supervised by State, district, and local leaders, working in cooperation with the county agricultural agents and the schools.

Cooperation.—State agricultural colleges, school officers, teachers, women's clubs, and other organizations.

Location.—Throughout the 33 Northern and Western States.

Date begun.—1912.

Results.—During the past year 209,178 boys and girls were enrolled in the club work, of whom 127,882 did the work as outlined and directed by leaders. Of this number, 82,264, or 64 per cent, not only completed the work but rendered complete and certified crop reports, as required by the leaders. Of the total number completing all the work required, 24,299 were engaged in productive projects or profit-making enterprises, in which they produced food products to the value of \$509,325. The 50 cooperative leaders employed in 28 States secured the cooperation and local leadership of 11,478 individuals, who assumed responsibility over local groups and clubs; 1,670 canning demonstrations were conducted by these cooperative leaders, attended by 156,580, and, in addition, they held 3,829 field meetings and visited 27,733 club plats. Cooperative leaders at the colleges of agriculture furnished and distributed 2,108,456 copies of club instructions, while this department furnished 1,140,146 copies. Reports from 3,155 homes where the canning-club instructions were used show 546,515 quarts of fruits and vegetables canned during the past year, about half of which was vegetables, windfall apples, and other food products of the farm and garden which frequently go to waste for want of a remunerative market.

Assignment.—O. H. Benson, G. E. Farrell.

Proposed expenditures, 1916-17.—\$85,400.

Farm-Management Demonstrations:

Object.—To demonstrate to farmers the importance of certain efficiency factors relating to the organization and administration of the farm, and to increase the efficiency of the county agricultural agent work.

Procedure.—Farm-management demonstrators are placed in each State to conduct demonstrations with groups of farmers in selected areas of the State in the following manner: (1) Analyses are made of the business of 50 to 100 farms in each area, with special reference to the labor income and the important factors governing the same. (2) Each farm operator whose business has been analyzed is encouraged to make and assisted in making such modifications in the organization of his farm business as promise to increase the efficiency of his business and the net income of the farm. (3) Arrangements are made with each cooperating farmer to keep a farm business record of his work covering each business year during which the demonstration is carried on. Farmers are assembled in small groups and instructed in methods of working out their own labor incomes and of analyzing their own business.

Cooperation.—State agricultural colleges.

Location.—Throughout the 33 Northern and Western States.

Date begun.—1914.

Results.—Thus far the work has consisted chiefly of analyses of the business of individual farms in selected areas, with special reference to the labor income and the important factors governing these. Analysis records have thus far been made for over 15,000 farms in 163 areas in 23 States. The summaries of about 9,000 of these records have been completed and sent to the farmers as a basis for modification in the organization of their farm business.

Assignment.—L. H. Goddard, E. A. Brown.

Proposed expenditures, 1916-17.—\$54,200.

Extension Work in Home Economics:

Object.—To organize, correlate, and conduct extension work in home economics with farm women for the purpose of securing efficiency and promoting prosperity and contentment in the farm home.

Procedure.—Women trained in home economics, and known as home demonstration agents, will be cooperatively employed by the U. S. Department of Agriculture, the State colleges of agriculture, and individual counties, who will devote their entire time to the organization and development of the home interests of the county in which they are respectively located and will give instruction through demonstrations and otherwise in such subjects as food values and the selection, preservation, preparation, and serving of foods; the making, care, and laundering of garments; house arrangement, equipment, and furnishings; sanitation, including water supply and sewage disposal; heat, ventilation, light, and insect control; and in the organization of women into groups where such organization is needed for the study of home and related problems. The special subjects selected for instruction and demonstration will be determined by the apparent needs of each community and by the willingness of the local people to cooperate. During the present year it is expected that work will be started in at least 15 counties. Eventually it is contemplated to locate a woman agent in practically all the counties in the 33 Northern and Western States. Assistance will also be given to the home economics departments of the agricultural colleges in developing their home economics extension work through movable schools and other work done by the home economics specialists with headquarters at the college.

Cooperation.—Office of Home Economics, other bureaus of the department, State agricultural colleges, counties, and local organizations.

Location.—Washington, D. C., and throughout 33 Northern and Western States.

Date begun.—February 1, 1916.

Results.—Home demonstration agents are now cooperatively employed in Sullivan County, N. H., Erie County, N. Y., St. Joseph County, Mich., Canyon County, Idaho, Maricopa County, Ariz., New Haven County, Conn., and Montgomery County, Ohio. Work under this project has too recently begun to warrant a statement of results.

Assignment.—Florence E. Ward.

Proposed expenditures, 1916-17.—\$19,410.

Total, Farmers' Cooperative Demonstrations in the Northern and Western States, \$498,880, including \$20,640 statutory.

[Research.]

FARMERS' INSTITUTES AND AGRICULTURAL SCHOOLS.**Farmers' Institutes and Movable Schools:**

Object.—To study the work of farmers' institutes, movable schools, and similar organizations, as carried on in this and other countries, especially with a view to devise and experiment with modified or new methods adapted to conditions in the United States; and to provide farmers' institute and extension workers with publications especially adapted to their needs.

Procedure.—Reports of the farmers' institutes, movable schools, and similar agencies at home and abroad are collected and studied, and an annual report is made on these. A new method of conducting movable schools by utilizing local talent in their management is now being tested. Syllabi and lantern slides for lectures at farmers' meetings are being prepared and distributed. Courses of study for movable schools are being prepared.

Cooperation.—Other bureaus of the department, which furnish the subject matter for the syllabi and courses.

Location.—Washington, D. C.

Date begun.—1904.

Results.—The demand for syllabi for lectures accompanied with lantern slides has greatly increased during the past year, having practically doubled that of any previous year. Three additional syllabi were published, as follows: "Swine in the United States," "Production of Eggs and Poultry on the Farm," and "Production of Clean Milk." Extension courses covering vegetable foods and soils, each containing 12 lectures, were prepared. Syllabi for lectures on "Alfalfa," "Corn Production," "Cattle-Tick Eradication," and "How to Make Good Farm Butter" are in manuscript form. It has been demonstrated that the reports on farmers' institutes and syllabi for lectures have been useful to all classes of extension workers, including county agricultural agents, farmers' institute lecturers, extension teachers in agricultural colleges and agricultural high schools, grange lecturers, rural school superintendents, rural sanitary officers, rural preachers, etc.

Assignment.—J. M. Stedman.

Proposed expenditures, 1916-17.—\$9,500.

Investigations of Agricultural Instruction in Schools:

Object.—To study the methods and subject matter of school instruction in agriculture in this and other countries, with a view to determine the needs of such instruction, in order to make it practically useful to students who are to become farmers or workers in agricultural institutions; and to furnish schools with up-to-date and properly organized subject matter and illustrative materials to supplement and reinforce textbooks and field practice.

Procedure.—Schools are visited and conferences held with school officers and teachers, professors of agricultural education, etc. Reports and catalogues and other publications of agricultural schools at home and abroad are collected and studied. Publications outlining courses of study and lessons, as well as practical exercises, are prepared; also lantern slides, charts, and other illustrative material especially adapted to school use.

Cooperation.—Department bureaus, Bureau of Education, State agricultural colleges and schools, and school officers.

Location.—Washington, D. C.

Date begun.—1904.

Results.—During the past year the preparation of brief pedagogical statements on how to use certain farmers' bulletins in connection with the teaching of agriculture in rural schools was begun, six such statements having been prepared. The preparation of a series of bulletins showing how the boys' agricultural club projects may be utilized by the rural school teacher in giving agricultural instruction was also begun.

Bulletins containing courses in agriculture for the rural schools of Wisconsin and Maryland were published in cooperation with the State agricultural college and State department of public instruction in the respective States. Manuscripts have been prepared covering "Lessons on Tomatoes for Rural Schools," "Lessons on Poultry for Rural Schools," "Judging the Dairy Cow as a Subject of Instruction in Secondary Schools," and "School Credit for Home Practice in Agriculture." A set of lantern slides has been prepared which deals in detail with school-garden work in connection with teacher training in a normal school, featuring how this may be correlated to the extent of vitalizing such subjects in the course of study, as arithmetic, drawing, and language.

Investigations of Agricultural Instruction in Schools—Continued.

Four conferences of workers interested in secondary agricultural education were held—two in the North Atlantic States, one in the North Central States, and one in the South. At these conferences courses of instruction in agriculture suited to the high schools in these regions were outlined and discussed. During the year considerable progress was made in preparing and publishing outlines for practical instruction in a number of agricultural subjects in secondary schools.

In cooperation with the Association of American Agricultural Colleges and Experiment Stations, a study of courses for preparing agricultural extension workers was made and the results published.

In general, it may be said that much more systematic attention is being given to problems of agricultural education from a practical standpoint by many schools. Interest in the study of practical problems of agricultural instruction has been greatly promoted and the development of agricultural schools with practical aim and instruction materially aided.

Assignment.—C. H. Lane.

Proposed expenditures, 1916-17.—\$16,400.

Total, Farmers' Institutes and Agricultural Schools, \$25,900, including \$5,300 statutory.

[Research.]

HOME ECONOMICS INVESTIGATIONS.**Respiration Calorimeter Investigations:**

Object.—To study agricultural products with reference to their use in the home for food, clothing, and equipment, and the household tasks which their use involves, and to cooperate with other bureaus in investigations of problems for which the equipment and experience of this laboratory are specially suited.

Procedure.—Special calorimetric methods are used in the systematic study of food, clothing, and household equipment in relation to work in the home, and in the special studies undertaken in cooperation with other bureaus.

Cooperation.—Other bureaus of the department.

Location.—Washington, D. C.

Date begun.—1894.

Results.—The work continues to supply, as it has done in the past, more exact information regarding the subject matter of home economics than has hitherto been available for the use of extension workers, teachers, students, and housekeepers, while the cooperative investigations furnish data necessary for the proper solution of various agricultural problems. During the past year information has been accumulated upon the expenditure of energy by the body in the performance of household tasks under different conditions, the transformations of matter and energy by bees in winter conditions, and physiological activities of hens' eggs during incubation. Manuscripts have been prepared for publication under the following titles: "A Respiration Calorimeter for the Study of Problems of Incubation in Hens' Eggs," "A Respiration Calorimeter, Partly Automatic, for the Study of Metabolic Activity of Small Magnitude," and "The Intensity of Change in Fruit during Ripening and Storage as Measured by Gaseous Exchange and Energy Output."

Assignment.—C. F. Langworthy, R. D. Milner.

Proposed expenditures, 1916-17.—\$9,100.

Studies of Food, Dietetics, Clothing, and Household Equipment, Work, and Management.

Object.—To study the nature of agricultural products used in the home for food, clothing, and equipment; to study household processes, methods, and uses pertaining thereto; to classify, compare, revise, and digest information useful to extension workers, housekeepers, teachers, and students; and to make available for their needs the results of research.

Procedure.—The systematic study by general and special research methods of the nature and uses of foods, clothing, household textiles, and other household supplies; and the dissemination of the results of research in home economics through publications and by other means.

Cooperation.—Other bureaus of the department and other departments.

Location.—Washington, D. C.

Date begun.—1894, as regards foods; 1914, as regards clothing, household equipment, and household management.

Studies of Food, Dietetics, Clothing, and Household Equipment, Work, and Management—Continued.

Results.—Much information, both general and specific, has been brought together and distributed by means of bulletins and in other ways, which helps the housekeeper to understand her materials and to use them to good advantage. In its earlier years the work had to do chiefly with food materials and dietetics, with the result that the housekeeper has been provided with information as to food requirements as affected by sex, age, and activity, and with dietary standards; also with a knowledge of food preparation and of cooking processes and their effects upon foods, the selection and combination of foods to form rational meals, the relative economy of different foods, their care in the home, etc. The reorganization of the work makes it possible to provide equally useful information regarding clothing, household equipment, and household labor. During the past year Department Bulletin 310, "Digestibility of Some Animal Fats," was published, and the results of additional experiments with animal and with vegetable fats await publication. Technical bulletins have also been prepared on "The Digestibility of the Grain Sorghums," "Methods for the Removal of Stains from Clothing and Household Textiles," "The Digestibility of the Hard Palates of Cattle," and "The Digestibility of Very Young Veal"; also an article on "Woman's Work in the Farm Home," to appear in the Department Yearbook for 1916, as well as professional papers and popular bulletins on the preparation of food, the planning of meals, home management, and other household topics. The popular articles published include Department Yearbook Separate 646, "Selection of Household Equipment," Farmers' Bulletin 717, "Food for Young Children," and Farmers' Bulletin 712, "School Lunches." Others have been prepared and await publication.

Assignment.—C. F. Langworthy, R. D. Milner.

Proposed expenditures, 1916-17.—\$20,880.

Total, Home Economics Investigations, \$29,980, including \$5,760 statutory.

OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING.

GENERAL ADMINISTRATION.

General Administration:

Object.—To administer the investigational activities of the office; to carry on its business affairs, correspondence, accounting, etc.

Location.—Washington, D. C.

Date begun.—1893.

Assignment.—L. W. Page, P. St. J. Wilson, W. Carl Wyatt.

Proposed expenditures, 1916-17.—\$15,760, including \$3,160 statutory (research, \$10,506; extension, \$5,254).

ROAD MANAGEMENT.

Supervision:

Object.—To direct and supervise the various research and extension activities under this group and conduct routine office business, including correspondence, maintenance of records, purchase of supplies and equipment, and other clerical work.

Location.—Washington, D. C.

Date begun.—1905.

Assignment.—J. E. Pennybacker.

Proposed expenditures, 1916-17.—\$13,118 (research, \$9,838; extension, \$3,280).

[Research.]

(Collection of Data on Road Mileage, Revenues, and Expenditures, 1914:

Project completed and results prepared for publication. The information obtained covered total road mileage and mileage of improved roads of each type in each county in the United States as of December 31, 1914, the sources and amounts of all road revenues, the amounts of bond issues and the bonds outstanding, and rates of interest, etc., for bonds issued during that year. In many cases additional information was obtained as to administrative organization, etc.)

Collection of Current Data Relating to Highways:

Object.—To determine and systematize all available information and statistics relative to highways, including the maintenance of a current record and the compilation of road legislation. This project covers all statistical studies except the census of road mileage, revenues, and expenditures made at five-year intervals, and is to provide necessary information of a general or statistical character for the use of persons engaged in or aiding road improvement.

Procedure.—A collaborator is employed in each State, who reports, under prescribed headings, from time to time. The information thus obtained is assembled in a State index, which is kept up to date. In addition, special inquiries are sent from time to time to State highway departments and other sources of information, the compilation of road laws is conducted, and all technical and trade publications bearing upon road improvement are freely consulted. Publications are issued from time to time containing data thus obtained.

Cooperation.—State highway departments and various other sources of information.

Location.—Washington, D. C.

Date begun.—1905.

Results.—(1) During 1916: Very much amplified circulars on the subjects covered by the circulars issued in 1915 have been prepared and are ready for publication. The current material is also used freely for correspondence and reference purposes.

(2) Prior to 1916: Information assembled was used for general reference purposes, and blue-print tables of mileage, expenditures, etc., were issued from time to time. During 1915 a circular was issued giving State highway mileage

Collection of Current Data Relating to Highways—Continued.

and expenditures for the calendar year 1914, and another circular was issued giving automobile registrations and amounts derived therefrom and applied to roads.

Assignment.—A. P. Anderson, L. E. Boykin.

Proposed expenditures, 1916-17.—\$4,740.

Utilization of Convict Labor in Road Management:

Object.—To study the management, operation, discipline, and results obtained in convict road camps, and to test, under cooperative arrangements with State and local authorities, systems of record, cost keeping, and management devised by this office, and to disseminate the results obtained by these studies and tests in publications to be issued by this office.

Procedure.—Personal visits are made by representatives of this office and special reports prepared by collaborators appointed at selected camps.

Cooperation.—State highway departments, State prison commissions, and boards of county commissioners and supervisors.

Location.—Various points yet to be definitely selected; advice given at points as covered by requests from time to time by State and local officials.

Date begun.—1914.

Results.—(1) During 1916: A comprehensive bulletin has been sent to the printer, and other publications will later be issued.

(2) Prior to 1916: The results under this project covered only the assembling of data to be used later in the preparation of a bulletin.

Probable date of completion.—1917.

Assignment.—H. S. Fairbank.

Proposed expenditures, 1916-17.—\$2,621.

Observation of Experimental Convict Camp in Connection with Road Management:

Object.—To ascertain, by observation of a camp constructed and operated by the county commissioners of Fulton County, Ga., as an experimental camp, the most practicable structures, equipment, sanitation, clothing, diet, organization, discipline, and methods of management to be used in connection with the use of convicts for road construction.

Procedure.—The board of county commissioners of Fulton County, Ga., established a demonstration convict camp with the approval of the State prison commission, at which camp the recommendations of this office with reference to structures, management, record, etc., were followed and the recommendations of the Public Health Service adopted as to sanitation, diet, and health conditions. The county board agreed to bear the entire expense of the camp, except that payment of small salaries to three of the officials and employees at the camp was made by this office in order to obtain the special reports and data contemplated in the investigation. At the completion of the demonstration it is proposed to issue a bulletin setting forth the results obtained.

Cooperation.—Public Health Service; Office of Home Economics, States Relations Service; State Prison Commission of Georgia, and Board of County Commissioners of Fulton County, Ga.

Location.—Fulton County, Ga.

Date begun.—January 1, 1916.

Results.—During the past fiscal year a complete camp has been established about 10 miles outside of the city of Atlanta, at which 40 convicts are quartered. The camp has been in operation since January 10, 1916, and up to June 30, 1916, no escapes or attempted escapes have been reported, although no guards, shackles, or other restrictions of a disciplinary character are used. The percentage of sickness has been less than one-third of 1 per cent, and the diet, which fully meets the standards of the Public Health Service, is giving general satisfaction and is costing about 20 per cent less than the diet which it superseded. An adequate system of cost keeping has been installed and unit costs of work are reasonably low.

Probable date of completion.—February 1, 1917.

Assignment.—R. F. Eastham.

Proposed expenditures, 1916-17.—\$3,000.

(Economic Studies of Highway Systems in Selected Counties: Annual studies covering a period of five years in eight selected counties have been completed, showing the financial burden imposed upon communities through the construction of improved roads and the corresponding benefits obtained through increase in land values, lowering of cost of hauling, improvement of school

Economic Studies of Highway Systems in Selected Counties--Continued.

facilities, etc. Full details as to construction and maintenance were included in the data obtained, and an excellent series of photographs showing the same roads at the same points during each of the five years was secured. The data for each of the eight counties have been utilized in the preparation of a bulletin, which is now in the hands of the printer.)

Economic Studies of Selected Post Roads:

Object.—To comply with a provision in the Post Office Department appropriation act of August 24, 1912, requiring the gathering of information of an economic character on post roads improved with the aid of a Federal appropriation of \$500,000. The project involves studies of the character and amount of traffic, cost of hauling, financial outlay, benefits to the community, and saving to the Government in the operation of rural delivery and parcel post.

Procedure.—Engineers are assigned to visit the post roads and make thorough studies before improvement is begun and after the roads are completed. The information thus obtained will be embodied in a report to be submitted to Congress.

Cooperation.—Post Office Department.

Location.—Lauderdale County, Ala., Boone, Story, and Dubuque Counties, Iowa, Montgomery and Bath Counties, Ky., Cumberland and Sagadahoc Counties, Me., Montgomery County, Md., Lefflore and Carroll Counties, Miss., McDowell, Forsyth, Davis, and Iredell Counties, N. C., Muskingum and Licking Counties, Ohio, Jackson County, Oreg., Aiken County, S. C., Montgomery and Loudon Counties, Tenn., Travis, Hays, Comal, Bexar, and Guadalupe Counties, Tex., and Spotsylvania, Caroline, Hanover, and Fairfax Counties, Va.

Date begun.—1913.

Results.—Studies have been completed on nine post roads and material is ready to be utilized in cooperation with the Post Office Department in making final report to Congress. Final studies are yet to be made on eight roads.

Probable date of completion.—October 1, 1916.

Assignment.—W. E. Rosengarten.

Proposed expenditures, 1916-17.—\$934.

Economic Studies of County and Township Highway Systems:

Object.—To ascertain by personal studies the organization, procedure, cost of operation, and results obtained in counties and townships in various parts of the United States; to find out the types of road, character of materials, and methods of maintenance which are yielding the best results at the least cost; and to determine the elements of weakness in various local systems of management. This information is to be used as a basis for the preparation of a series of bulletins bearing upon local road construction, maintenance, and administration. Two bulletins have been determined upon as a result of these studies, namely, highway organization and management, and highway records, cost keeping, and accounting.

Procedure.—Approximately 100 counties have been selected, located in various parts of the United States and presenting all conditions that exist in the United States as to character of material, methods of construction, topography, character and extent of traffic, systems of organization, methods of financing construction and maintenance, etc., and each of these selected counties is made the object of a thorough study by an engineer assigned for that purpose. It is believed that these 100 counties will form an accurate index for the country as a whole. The individual reports by counties will be filed in the office and will be utilized in the preparation of bulletins. Studies have been completed in half of the counties selected and further studies will be made. In connection with the proposed bulletin on highway records, cost keeping, and accounting, it proposed to demonstrate in three counties the systems to be devised.

Cooperation.—Local officials.

Location.—Various counties throughout the United States.

Date begun.—1914.

Results.—Field studies have been completed in 50 counties and a cost-keeping bulletin begun.

Probable date of completion.—June 30, 1917.

Assignment.—J. J. Tobin, H. S. Fairbank.

Proposed expenditures, 1916-17.—\$5,400.

Economic Studies of State Highway Departments:

Object.—To ascertain the character of organization, working plan, cost of operation, and systems of report and record character of work done and relative results accomplished by the various State highway departments in the construction and maintenance of roads and bridges. This information will be useful to each State in the efficient and economical handling of its State road work.

Procedure.—An engineer has been assigned to personally visit each State highway department, confer with officials, examine records, inspect work under way, prepare notes, and obtain all necessary records, forms, and data for the preparation of a report. As soon as all studies have been completed, one or more bulletins will be prepared for publication.

Cooperation.—State highway departments.

Location.—All States having highway departments.

Date begun.—1914.

Results.—Studies have been completed in 15 States and considerable office work has been done toward the preparation of a bulletin.

Probable date of completion.—March 1, 1917.

Assignment.—J. D. Fauntleroy, L. I. Hewes.

Proposed expenditures, 1916-17.—\$5,660.

Traffic Studies:

Object.—To assemble all practicable data on the regulation of traffic, the adaptation of various types of road surface to traffic conditions, and the relation of maintenance methods and cost to traffic requirements.

Procedure.—Engineers will be assigned to study the methods pursued in various States and counties with reference to the handling of traffic problems, and information will be compiled in this office by correspondence and by a study of laws and reports, which information will be correlated with the field investigations made by engineers.

Location.—Various points to be determined from time to time.

Date begun.—1912.

Results.—(1) During 1916: Traffic studies on post roads have been nearly completed and the information obtained is being compiled for use in a report to Congress. Traffic censuses are being continued on the experimental roads already constructed by this office.

(2) Material assembled prior to 1916 has been used indirectly in connection with Department Bulletin 136, "Highway Bonds," and with reports on experimental roads constructed by the office.

Assignment.—L. I. Hewes, W. E. Rosengarten.

Proposed expenditures, 1916-17.—\$4,552.

[Extension.]

Advice, Lectures, and Demonstration of Road and Bridge Models:

Object.—To provide expert advice on legislation, organization, and road management, and to aid in intelligent propaganda through conferences, lectures, and demonstrations.

Procedure.—Advice, lectures, and demonstrations are given upon the request of public officials and organizations. The models are sent out on condition that transportation expenses will be paid by the local organizations. Demonstrators are assigned at the expense of the office. Models are made and lantern slides are made and colored in the office for use in this work.

Cooperation.—Highway officials, public and private organizations, and State agricultural colleges through the States Relations Service.

Location.—United States.

Date begun.—1893.

Results.—As this is a current project, consisting of dissemination of information of great practical educational value and the stimulation of interest in practical road improvement, the results are fairly similar each year.

Assignment.—M. O. Eldridge, L. E. Boykin, L. I. Hewes, J. J. Tobin, J. D. Fauntleroy, R. F. Eastham, H. S. Fairbank.

Proposed expenditures, 1916-17.—\$18,253.

(Instruction of Students in Highway Engineering: Quite a number of engineer students have in the past been given a one-year course in this office and have been promoted to the grade of junior highway engineer and from that grade to highway engineer and senior highway engineer. The project has been discontinued owing to the fact that most of the States have now established State

Instruction of Students in Highway Engineering—Continued.

highway departments and that a very large number of educational institutions are devoting attention to instruction in highway engineering. Through these means, both theoretical and practical knowledge of highway engineering is being acquired by a large number of highway engineers, thus obviating the necessity of continuing the policy which was based upon an inadequate supply of competent highway engineers.)

Total, Road Management, \$58,278, including \$18,738 statutory (research, \$36,745; extension, \$21,533).

ROAD BUILDING AND MAINTENANCE.**Supervision:**

Object.—To direct and supervise the various research and extension activities under this group and carry on routine office business, including correspondence, maintenance of records, purchase of supplies and equipment, and other clerical work.

Location.—Washington, D. C.

Date begun.—1904.

Assignment.—P. St. J. Wilson, Vernon M. Peirce, E. W. James, T. Warren Allen.

Proposed expenditures, 1916-17.—\$9,980 (research, \$1,554; extension, \$8,426).

[Research.]

(Study of Representative State Systems of Road Maintenance: Discontinued as a separate project; included under "Economic Studies of State Highway Departments," Road Management.)

(Study of Representative County Systems of Road Maintenance: Discontinued as a separate project; included under "Economic Studies of County and Township Highway Systems," Road Management.)

Investigation of Costs of Road Maintenance:

Object.—To investigate costs of maintenance and to secure accurate cost data for various types of road.

Procedure.—In counties where roads have been systematically improved under the direction of competent engineers, certain sections of the improved roads are selected for the purpose of determining the relative value of various types of construction. The length of roads selected is from 15 to 40 miles, and the maintenance is conducted by the various counties. A nominal cost for furnishing these maintenance data is paid by the office. Traffic observations are to be taken on these roads for two or more periods of one week each for the purpose of amplifying and checking the observations made in connection with the experimental roads.

Cooperation.—State highway departments or road authorities in the several counties.

Location.—Calcasieu Parish, La., Forrest County, Miss., Montgomery County, Ala., Cumberland County, Me., Cayuga County, N. Y., Berrien and Genesee Counties, Mich., Atlantic County, N. J., Milwaukee County, Wis., and Muskingum and Licking Counties, Ohio.

Date begun.—1907.

Results.—(1) During 1916: Special attention has been paid to the collection of accurate information which will be used in establishing a definite relation between the amount of traffic and the cost of maintaining the various types of road surfaces.

(2) Prior to 1916: Accurate data have been secured covering the cost of maintenance of dirt, gravel, and bituminous macadam roads. Reports for the past year's work are to be published in the "Annual Progress Report for 1915."

Assignment.—E. W. James.

Proposed expenditures, 1916-17.—\$3,260.

[Extension.]**Object-Lesson Roads:**

Object.—To give assistance to local road authorities by demonstrating proper methods of construction and the most efficient use of materials, to instruct them in the art of road building, and to correlate conclusions drawn from laboratory tests with those resulting from field service tests.

Object-Lesson Roads—Continued.

Procedure.—Applications are received from local road authorities for advice and assistance in the construction of roads where funds are available and everything is ready for the work to proceed. These applications are acted upon, as far as possible, in the order of their receipt by this office. A highway engineer is detailed to superintend the construction of a short section of road as an object lesson to the local authorities and remains upon the job until he has thoroughly instructed the foreman, who is then able to continue the work after the engineer has been given another assignment.

Cooperation.—State, county, and township authorities who have legal control of the roads to be improved, and the State agricultural colleges through the States Relations Service.

Location.—Object-lesson roads have been built in a great many different localities throughout the United States, and any political unit, excepting incorporated towns and cities, which makes proper application may receive this kind of assistance.

Date begun.—1904.

Results.—Local officials in charge of road work have been instructed as to the best methods of road construction, and improved methods of construction have been adopted by many of the various localities in which these roads have been built. Information has been secured and disseminated as to the cost and best methods of road construction.

Assignment.—Vernon M. Peirce.

Proposed expenditures, 1916-17.—\$24,413.

County Road Systems:

Object.—To make a study of the roads of a county or other political subdivision and prepare general plans and specifications for their administration, improvement, and maintenance.

Procedure.—Experienced highway engineers are sent upon requests from county officials having jurisdiction of roads to advise with them in connection with the improvement of the county system of road supervision, improvement, and maintenance. These engineers go over the situation thoroughly, taking into account all the factors entering into the local problem and then, in the light of their wide experience, formulate a plan of action for the improvement of the roads throughout the county, considering the county as a unit.

Cooperation.—County officials in charge of roads in the various counties seeking this character of assistance. The Office of Public Roads and Rural Engineering furnishes a consulting engineer to cooperate with local officials.

Location.—Any county or political subdivision of similar size and importance which makes proper application, and the State agricultural colleges through the States Relations Service.

Date begun.—1907.

Results.—Many counties have adopted the department's recommendation, reorganized and systematized their highway improvement work, and are now working along definite lines as to the ultimate system of roads that will be built, their methods of construction, and administration.

Assignment.—Vernon M. Peirce.

Proposed expenditures, 1916-17.—\$21,213.

Inspection, Advice, and Lectures:

Object.—To make inspections, study specific local road problems, prepare definite recommendations for their solution, and bring this information to the assistance of those who have asked for it.

Procedure.—Upon request of road officials or interested civic organizations for assistance in the nature of advice, highway engineers are detailed to make inspections of local conditions, and then give the required advice. Occasionally such engineers deliver lectures before meetings of road officials, highway associations, and mass meetings of citizens on specific and general highway improvement problems.

Cooperation.—Township and county authorities in legal control of the roads. The Office of Public Roads and Rural Engineering furnishes a consulting engineer to cooperate with the local officials.

Location.—Any political unit in the United States, except incorporated towns and cities, which makes proper application.

Date begun.—1894.

Inspection, Advice, and Lectures—Continued.

Results.—Requests are constantly being received for work under this project, and they are cared for as far as possible in the order of their receipt by this office. Many communities have secured the improvement of their roads in accordance with the advice given, and some have employed experienced highway engineers to continue such work. The lectures have resulted in informing a considerable number of residents of each community how the road should be improved, the approximate cost of same, and the results and benefits to be expected.

Assignment.—Vernon M. Peirce.

Proposed expenditures, 1916-17.—\$31,526.

Superintendence of County Roads:

Object.—To demonstrate to county officials the advantages accruing from the supervision of all county roads by one skilled in highway construction and maintenance and the advantages of centralized control over all roads in a county.

Procedure.—When application for assistance has been made and contract entered into with this department, an engineer is assigned to take charge of the maintenance and construction of the county roads. This engineer supervises the building of roads and bridges, organizes a system for maintaining the roads, and introduces proper systems of reports and methods of accounting.

Cooperation.—County officials in legal control of the roads who have made application for assistance of this kind.

Location.—Any county which makes proper application.

Date begun.—1911.

Results.—County officials are convinced of the advantages of centralized control in the hands of qualified men, adopt the systems recommended, and elect or appoint county highway engineers.

Assignment.—Vernon M. Peirce.

Proposed expenditures, 1916-17.—\$20,177.

Bridge Construction in Connection with Road Building and Maintenance:

Object.—To furnish local officials with plans and specifications for bridges and to investigate conditions and advise the authorities interested as to the best methods of bridge construction to meet their peculiar needs and conditions.

Procedure.—Standard plans and specifications of various types of structures are prepared in the office and furnished to local officials and engineers upon request. Engineers visit communities and advise the authorities interested relative to special bridge problems and prepare plans to suit local conditions. They also superintend the construction of bridges to illustrate to local officials proper methods of construction.

Cooperation.—State, county, and township authorities in legal control of the roads. The Office of Public Roads and Rural Engineering furnishes a consulting engineer to cooperate with the local authorities.

Location.—Any State or political subdivision, except incorporated cities or towns, which makes proper application.

Date begun.—1909.

Results.—Highway officials in various communities have been furnished plans and specifications and have been advised as to the best types and methods of bridge construction.

Assignment.—O. L. Grover, O. W. Childs.

Proposed expenditures, 1916-17.—\$9,847.

Improvement of Roads in National Forests:

Object.—To advise with the Forest Service as to the best methods of constructing and maintaining roads and to make surveys and supervise the construction of roads in the various United States national forests.

Procedure.—Surveys and plans are made for the construction of roads in national forests and advice rendered counties interested in opening roads across national forests.

Cooperation.—Forest Service.

Location.—National forests.

Date begun.—1906.

Results.—An engineer of this office has been stationed in each of the Forest Service districts Nos. 2, 3, 4, 5, and 6.

(1) During the year 1916 a number of projects were under way, among the most important of which were the following: In district No. 2 the Rabbit Ear road, 7 miles in length, in Routt Forest, Colo., opens up the road from Steamboat Springs to Denver. In district No. 3 the Tucson-Mount Lemon road, an extremely difficult piece of location, in the Colorado Forest, Ariz., is approxi-

Improvement of Roads in National Forests—Continued.

mately 22 miles in length. In district No. 4 considerable construction work has been done on the Payette River road, 20 miles in length, located in the Boise Forest of Idaho. In district No. 5 the Trinity River road is under construction. This road is 14 miles in length and is located in the Trinity Forest, Cal. In district No. 6 the most important accomplishment during 1916 was the survey of the Mount Hood Loop road in the State of Oregon. This will be a very important highway, much on the order of the Columbia River Highway, and will assist materially in the development of the Oregon forest reserves.

(2) Prior to 1916: In former years a number of reconnaissances and construction surveys were made and several construction projects completed, among which are the Alsea River road in Siuslaw Forest, Oreg.; the Cochetopa Pass road in Cochetopa Forest, Colo.; the Pecos-Panchuela road in Santa Fe Forest, N. Mex.; the Icehouse road, Eldorado Forest, Cal.; and the Salina Canyon road in Fishlake Forest, Utah.

Assignment.—T. Warren Allen.

Proposed expenditures, 1916-17.—\$16,353.

(Improvement of Roads in National Parks: Project discontinued. The Department of the Interior has appointed a superintendent of parks, who will have in charge the work heretofore done under this project. The department will cooperate in an advisory capacity, but no expenses will be involved. As a result of past work surveys have been made for a number of roads throughout the national parks.)

Road Maintenance:**(a) POST ROADS—**

Object.—To supervise the maintenance of certain post-road projects for the purpose of determining accurately the relation between the cost of effective maintenance and the available local funds and of determining maintenance costs on various types of roads; and to advise local road authorities.

Procedure.—The post roads built with funds provided under the act of August 24, 1912, are of concrete, bituminous, gravel, and macadam construction, and will be maintained, if possible, with local funds under the supervision of this office. This work will provide an unusual opportunity for the Government to secure accurate and detailed maintenance cost data on a large number of types of construction not otherwise available to it, and will provide information desired and more and more frequently requested by engineers and local officials in all parts of the country.

Cooperation.—Local administrative units cooperating in post-road construction.

Location.—Maine, Ohio, Maryland, Virginia, South Carolina, and North Carolina.

Date begun.—1914.

Results.—(1) During 1916: Systematic maintenance has been inaugurated on the Ohio post road, Maine post road, and Maryland post road. Arrangements are being made for organizing maintenance on the Virginia post road, in Fairfax County. Further, the North Carolina post road, in Forsyth and Davie Counties, has been placed under the supervision of the engineer in charge of the western section of the central highway in North Carolina, and funds for maintenance have been provided by the respective counties. The South Carolina post road, in Aiken County, has been placed under the supervision of the engineer in charge of maintenance on the southern section of the Washington-Atlanta Highway, and tentative plans provide for converting this post road into an experimental road for the purpose of making very accurate studies of the endurance of sand-clay and top-soil construction.

(2) Prior to 1916: This project was begun in 1914, but the more important post roads had not been completed at that time and it was not until the summer of 1915 that it became possible to interest the local administrative units in maintaining the roads constructed. There were no funds available from which this office could give assistance in the maintenance of any post road, except by furnishing engineering supervision, and for this reason in those sections where post roads were of dirt or cheap types of construction the counties were found to be either without adequate funds to maintain the roads or were unwilling to devote any more of their local annual revenue to the work.

Assignment.—E. W. James.

Proposed expenditures, 1916-17.—\$2,500.

(b) WASHINGTON-ATLANTA HIGHWAY—

Object.—To supervise the maintenance of the Washington-Atlanta Highway and thereby demonstrate maintenance methods to county officials; also to study the cost of effective road maintenance in the coastal-plain region.

Road Maintenance—Continued.

Procedure.—The route selected between Washington and Atlanta is divided into three sections, to each of which is assigned an engineer to supervise maintenance and repair. These men travel over their sections, giving personal directions to patrolmen and repair gangs, and act in cooperation with local officials and engineers in promoting better maintenance methods.

Cooperation.—Counties and their subdivisions on the route and the American Highway Association. The work is subject to a cooperative arrangement between the Government and the local units, as the cost of actual maintenance is met from local funds.

Location.—Lunenburg, Mecklenburg, and Nottaway Counties, Va.; Cumberland, Harnett, Johnston, Wake, Durham, Granville, Hoke, Moore, and Richmond Counties, N. C.; Chesterfield, Aiken, and Lexington Counties, S. C.; and Clarke, Dekalb, McDuffie, Morgan, Oglethorpe, Walton, and Warren Counties, Ga.

Date begun.—1914.

Results.—(1) A total of 662.2 miles of road in the above counties was under the supervision of this office during the calendar year 1915, which is about 75.6 per cent of the total distance from Petersburg, Va., to Atlanta, Ga. There has been expended on maintenance alone \$26,082.56 to December 31, 1915, and \$29,005 has been allotted for maintenance, available up to varying dates, depending on the time application was made. Construction has continued during the past year on sections of road in unsuitable condition for maintenance, and \$120,680.11 was expended on this work under the direction of the office. Heavy repairs, reconstruction or construction, was done on 165.95 miles. Two counties refused to continue cooperation, and two additional counties voluntarily made application at once to replace them. An account of the past year's work appeared in the Richmond Motorist for April, 1916. From March 3, 1915, to June 30, 1916, the entire mileage, including long sections of earth road, was kept open to traffic at every point. This is the first time in the history of the section traversed that such a mileage of road has been useful during an entire winter. The accumulative effect of continuous systematic maintenance is being demonstrated.

(2) An account of the work on the Washington-Atlanta Highway appeared in the Manufacturers Record of April 6, 1915. Six hundred and eighty-one and eight-tenths (681.8) miles were under supervision and \$10,042.17 were spent for maintenance from May, 1914, to December, 1914, inclusive. Unconstructed sections of the road were built at a cost of \$75,785.95, construction work being done on 153.7 miles. During the winter of 1914-15 the road was kept open at all points, except from December 23 to the second week in February.

Assignment.—E. W. James, D. H. Winslow, W. L. Spoon, George C. Scales, V. E. Towles.

Proposed expenditures, 1916-17.—\$10,596.

(ORGANIZED MAINTENANCE OF BOND-AIDED ROADS: Project discontinued because of the difficulty of arranging satisfactory cooperation. It is believed that funds can be used to better advantage in other directions.)

(c) **CENTRAL HIGHWAY IN NORTH CAROLINA—**

Object.—To supervise the maintenance of the Central Highway in North Carolina from Beaufort to the Tennessee line in such counties as apply for cooperation; to demonstrate maintenance methods to county officials, and to study the organization of effective maintenance in the Piedmont and mountain sections of North Carolina.

Procedure.—The highway is divided into two sections, one east of Durham and one west of Durham, to each of which an engineer is to be assigned. These men will travel over their sections giving personal directions to patrolmen and repair gangs and act in cooperation with local officials and engineers in promoting better maintenance methods.

Cooperation.—State Highway Commission of North Carolina, counties, and townships on the route.

Location.—Carteret, Craven, Lenoir, Wayne, Guilford, Davidson, Rowan, Johnston, Durham, Orange, Alamance, Iredell, Forsyth, Davie, and Catawba Counties, N. C. This carries the work to the Burke County line, and the project will be continued westward as rapidly as possible.

Date begun.—1916.

Road Maintenance—Continued.

Results.—This project is new and about to be inaugurated. The exact mileage figures are not yet available, but about 90 per cent of the entire road will be covered by application from the various counties.

Assignment.—E. W. James, D. H. Winslow, W. L. Spoon.

Proposed expenditures, 1916-17.—\$4,386.

Improvement of Post Roads:

Object.—To construct and improve highways over which United States mail is carried for service tests by the Post Office Department, pursuant to the act of August 24, 1912, and to ascertain the economic value of such improvement to the community.

Procedure.—The construction of such roads as have been selected by the Postmaster General and the Secretary of Agriculture to be improved under the terms of the act of Congress of August 24, 1912.

Cooperation.—Post Office Department, States, counties, and townships.

Location.—See table which follows.

Date begun.—See table which follows.

Results.—Fourteen projects as shown below have been completed, resulting in the improvement of 351.53 miles of road.

(1) The following post roads were completed during the fiscal year 1916: Montgomery and Bath Counties, Ky., Cumberland County, Me., Leflore County, Miss., Davie, Forsyth, and Iredell Counties, N. C., Aiken County, S. C., Loudon and Montgomery Counties, Tenn., Austin-San Antonio road, Tex., and Fairfax County, Va.

(2) The following post roads were completed prior to the fiscal year 1916: Lauderdale County, Ala., Boone and Story Counties, Iowa, Montgomery County, Md., Jackson County, Oreg., and Spotsylvania, Caroline, and Hanover Counties, Va.

Probable date of completion.—See table which follows.

Post roads completed and in course of construction.

Location.	Date begun.	Probable date of completion.
Lauderdale County, Ala.....	1913	Completed.
Boone and Story Counties, Iowa.....	1913	Do.
Dubuque County, Iowa.....	1914	Dec. 1, 1916.
Montgomery and Bath Counties, Ky.....	1913	Completed.
Cumberland County, Me.....	1914	Do.
Montgomery County, Md.....	1914	Do.
Leflore County, Miss.....	1913	Do.
McDowell County, N. C.....	1914	Dec. 1, 1916.
Davie, Forsyth, and Iredell Counties, N. C.....	1914	Completed.
Muskingum and Licking Counties, Ohio.....	1913	Aug. 1, 1916.
Jackson County, Oreg.....	1913	Completed.
Aiken County, S. C.....	1914	Do.
Loudon County, Tenn.....	1914	Do.
Montgomery County, Tenn.....	1914	Do.
Austin-San Antonio Road, Tex.....	1914	Do.
Fairfax County, Va.....	1913	Do.
Spotsylvania, Carolina, and Hanover Counties, Va.....	1913	Do.

Assignment.—Vernon M. Peirce, James T. Voshell.

Proposed expenditures, 1916-17.—\$4,327.

(Instruction of Students in Highway Engineering: Project discontinued. See statement relative to similar project under "Road Management.")

Total, Road Building and Maintenance, \$158,578, including \$15,798 statutory (research, \$4,814; extension, \$153,764).

Research.**ROAD-MATERIAL INVESTIGATIONS.****Supervision:**

Object.—To administer the various subactivities under this group and conduct routine office work, including correspondence, maintenance of records, purchase of supplies and equipment, preparation of specifications, participation in general administration of the office, and arrangement for cooperation with various divisions of the office.

Supervision—Continued.*Location.*—Washington, D. C.*Date begun.*—1904.*Assignment.*—Prévost Hubbard.*Proposed expenditures, 1916-17.*—\$8,180.**Routine Chemical Testing and Inspection:***Object.*—To conduct routine chemical tests and inspections of bituminous and nonbituminous dust preventives and road binders, with a view to determine their fitness for particular classes of work, conformity with specifications, etc. The inspection of culvert metal for use in roads built under the supervision of the office is also a part of this activity.*Procedure.*—Samples are tested free of charge when submitted by State and county officials, good roads organizations, etc., when by so doing information may be secured for the benefit of the office in its efforts to coordinate laboratory results with service tests and to aid it in the preparation of typical specifications for materials of this character. Materials for use in the general construction of experimental work of the office are also tested for their conformity to specifications, and when the quantity of material involved warrants it an inspection is made at the plant of the manufacturer.*Location.*—Washington, D. C., and occasionally at the plant where materials are manufactured.*Date begun.*—1904.*Results.*—(1) During the fiscal year 1916 the chemical laboratory examined 474 samples, including bituminous emulsions, fluxed native asphalts, oil asphalts, petroleum, residual petroleum, petroleum distillates, crude and refined coal tars and water-gas tars, bituminous aggregates, paving block, culvert metal, sand, cement, and concrete. The total number of samples exceeded that of any other fiscal year.

(2) Prior to 1916 the greatest number of samples examined during any one fiscal year was 419.

Assignment.—C. S. Reeve, B. Kamrass.*Proposed expenditures, 1916-17.*—\$4,632.**Microscopic Examination and Classification of Road-Building Rocks:***Object.*—To examine microscopically and classify road-building rocks and to study the relation existing between their physical properties and mineral composition; and to investigate the mineral composition of blast-furnace and open-hearth slags in relation to their road-building qualities.*Procedure.*—All samples of rock received for physical tests are submitted to the petrographer for identification and classification, and all crystalline rocks are subjected to microscopic examination for the purpose of determining their mineral composition.*Location.*—Washington, D. C.*Date begun.*—1901.*Results.*—(1) During 1916: The data obtained in this work are classified and studied, and the work to date has resulted in establishing some definite relations between the mineral composition and the physical properties of road-building rocks. Department Bulletin 348, "Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials," has been issued during the year. Approximately 900 samples of rock, gravel, sand, clay, slag, etc., have been examined and classified during the fiscal year.

(2) Prior to 1916: Office of Public Roads Bulletins 31 and 37 upon the examination and classification of rocks for road building were published; these discuss the physical properties of rocks with reference to their mineral composition and structure. A paper upon "The Composition and Properties of Slag for Road Making" was also published in the Proceedings of the Seventh International Congress of Applied Chemistry.

Assignment.—E. C. E. Lord.*Proposed expenditures, 1916-17.*—\$2,032.**Research on Dust Preventives and Road Binders:***Object.*—To investigate the effect of methods of production upon the character of bituminous materials, the relative fitness of the various types of bituminous materials for different classes of construction, and the changes which take place in these materials upon exposure to service conditions; and to conduct any other laboratory investigation which has for its purpose the production of improved materials or the securing of new data regarding materials at present in use.

Research on Dust Preventives and Road Binders—Continued.

Procedure.—Problems are suggested largely from observation of the behavior of materials in construction and maintenance work and are carried out when the volume of regular work permits.

Location.—Washington, D. C.

Date begun.—1910.

Results.—(1) During the fiscal year 1916 a paper upon "The Effects of Exposure on Tar Products" was prepared for publication; and an experimental refining plant for studying the manufacture of road materials from petroleum and tar was practically completed. A paper upon the effect of exposure on road oils and a bulletin upon the use of bituminous materials in the surface treatment and construction of highways are in course of preparation. The following subjects are under investigation: The effect of various solvents upon extracted bitumen; a study of asphalts by means of the penetration test; the relative binding value of various bitumens with different types of rock; bituminous materials suitable for use in the construction of top-soil roads; the thickness of films upon bituminous aggregates; a study of fluid bitumens by means of the viscosity test; a study of heavy refined tars by means of the float test; the effect of colloids in bituminous materials; the effect of oils in oil-cement concrete.

(2) Prior to 1916: An article upon the origin, manufacture, and use of bituminous and other materials in highway work was published under the title "Dust Preventives" as Office of Public Roads Bulletin 34. Other department publications include: Office of Public Roads Circulars—93, "Bitumens and Their Essential Constituents for Road Construction and Maintenance"; 96, "Naphthalene in Road Tars"; and 97, "Coke-Oven Tars of the United States." Articles were also published in the proceedings of various societies or in technical journals on the following subjects: The physical and chemical characteristics of bituminous road materials, the effect of free carbon in tars, the effect of traffic on macadam roads surfaced with heavy oils, organic residues from soluble bitumen determinations, and the effect of exposure on bitumens.

Assignment.—Prévost Hubbard, C. S. Reeve, R. H. Lewis.

Proposed expenditures, 1916-17.—\$4,032.

Experimental Bituminous Road Construction and Maintenance:

Object.—To develop new types of bituminous-bound and bituminous-treated roads, and to correlate laboratory experiments with service tests.

Procedure.—Upon approved application for assistance in utilizing local materials with an artificial binder, a laboratory investigation of the project is made and a chemist assigned to cooperate in the construction. The regular maintenance of experiments thus far constructed is also included under this project.

Cooperation.—State and county authorities.

Location.—Various parts of the United States.

Date begun.—1905.

Results.—(1) During 1916: Supervision or inspection has been conducted in the construction and maintenance of a number of experimental sections in the vicinity of Washington and at other places throughout the United States. This work has included inspection of the experimental work conducted in previous years and also new work. New lines of experiment include the use of Florida coralline rock with various types of bituminous material, the use of pit-run gravel in bituminous concrete, and the investigation of the comparative value of different types of rock with various bituminous materials in the construction of bituminous macadam and bituminous concrete roads. Plans have been completed or are being made to investigate the use of screened gravel in penetration macadam, the surface treatment of gravel roads with bituminous materials, and the use of bituminous materials in the construction of top-soil and sand-clay roads.

(2) Prior to 1916: Experiments have been conducted in various parts of the United States, and detailed data in connection with these experiments have been published as annual circulars of the Office of Public Roads and Rural Engineering, as bulletins in the departmental series under the general title "Progress Reports of Experiments in Dust Prevention and Road Preservation," and in Department Bulletin 284, "The Construction and Maintenance of Roads and Bridges."

Assignment.—Prévost Hubbard, C. S. Reeve.

Proposed expenditures, 1916-17.—\$3,832.

Physical Tests of Road-Building Materials:

Object.—To determine, by means of physical tests, the suitability of various materials for use in road construction.

Procedure.—Samples of rock, slag, gravel, sand, etc., are tested free of charge for any citizen of the United States and a report furnished him showing for what type of road construction the material is best suited.

Location.—Washington, D. C.

Date begun.—1893.

Results.—(1) During the fiscal year 1916 the physical laboratory tested 979 samples, including rock, gravel, sand, sand-clay, clay, top soil, cement, concrete, slag, shell, brick, etc. The total number of samples will probably greatly exceed that of any other past year. An article on "The Results of Physical Tests of Road-Building Rock" to date of January 1, 1916, was prepared for publication as Department Bulletin 370.

(2) The total number of samples of rock tested prior to 1916 was about 3,500. In 1912, Office of Public Roads Bulletin 44, "The Physical Testing of Road-Building Rock," was published.

Assignment.—F. H. Jackson, jr., C. E. Proudley, R. Harsch.

Proposed expenditures, 1916-17.—\$4,032.

Concrete Investigations:

Object.—To investigate the physical properties of concrete, including studies of the effect of flow, determination of the laws of expansion and contraction of concrete, factors involved in the distribution of stresses in reinforced slabs, study of strength of concrete bases, etc.

Procedure.—Tests are made on large-sized concrete specimens, such as cylinders, beams, and slabs. The loading is obtained by specially constructed apparatus at Arlington Farm, Va.

Cooperation.—American Society for Testing Materials and American Concrete Institute.

Location.—Washington, D. C., Arlington Farm, Va., Chevy Chase, Md., and Zanesville, Ohio.

Date begun.—1904.

Results.—(1) During 1916: An apparatus for measuring the wear of concrete roads was devised and used in connection with experimental roads constructed under the supervision of the office. A description of this apparatus was published in the Journal of Agricultural Research, vol. 5, No. 20, under the title "Apparatus for Measuring the Wear of Concrete Roads." Two papers were prepared upon slab tests under concentrated loading. One of these was published under the title "Tests of Three Large Size Reinforced Concrete Slabs under Concentrated Loading," Journal of Agricultural Research, vol. 6, No. 6. The other, entitled "Tests of Large Reinforced Concrete Slabs," was presented at a convention of the American Concrete Institute in January, 1916, and will be published in the 1916 Proceedings of the institute. These data point directly to a more economical design of bridge floors than has heretofore been used. A paper entitled "The Flow of Concrete under Sustained Loads" was also presented at the annual convention of the American Concrete Institute, January, 1916, and will be published in the Proceedings of that institute. In addition to the foregoing, the effect of time of mixing on concrete and the strength of concrete with different kinds of aggregate has been investigated. An article entitled "Oil-Mixed Portland Cement Concrete" was published as Department Bulletin 230.

(2) Prior to 1916 the following subjects were investigated and data published: "Cement Mortar and Concrete," Farmers' Bulletin 235; "The Use of Concrete on the Farm," Farmers' Bulletin 461; "Oil-Mixed Portland Cement Concrete," Office of Public Roads Bulletin 46; "The Expansion and Contraction of Concrete While Hardening," Proceedings of the American Society for Testing Materials, vol. 11, 1911; "The Dimensional Changes of Concrete While Hardening," paper presented before the Ohio State and Cleveland Engineering Society in 1911; "The Waterproofing Properties of Oil-Mixed Portland Cement Concrete," paper presented before the Indiana Engineering Society in 1911; "Some Tests of Reinforced Concrete Slabs under Concentrated Loads," published in the Proceedings of the American Society for Testing Materials, vol. 13, 1913.

Assignment.—A. T. Goldbeck, E. B. Smith.

Proposed expenditures, 1916-17.—\$11,112.

Nonbituminous Road-Material Investigations:

Object.—To investigate the physical properties of nonbituminous road materials, correlate the results of physical tests with behavior in actual service, and develop tests to meet new conditions in road construction.

Procedure.—Samples are obtained from various sources representing materials which have given known results in actual service. The data obtained form the basis for arriving at limiting values, used to determine the fitness of material for any given type of construction.

Cooperation.—Various State highway commissions.

Location.—Washington, D. C.

Date begun.—1893.

Results.—(1) During 1916: A paper upon the "Relation between the Properties of Hardness and Toughness of Road-Building Rock" was published in the Journal of Agricultural Research, vol. 5, No. 19. Data relative to the selection of rocks according to the results of physical tests as related to their use in different types of roads were also prepared for publication as a part of Department Bulletin 370, "Results of Physical Tests of Road-Building Rock." Investigations were continued on the toughness of cement mortars carrying various percentages of sand and cement; the relation between the physical properties and service results of road-building gravel; and waterproofing silos with oil cement. The following investigations were started: The effect of freezing and thawing on argillaceous rocks; the relative effect of mortar and sand cushions for brick; and the relation between the tensile strength of mortar and the mechanical analysis of sand.

(2) Prior to 1916: The results of researches were published in the proceedings of various societies under the following titles: "An Investigation of the Physical Properties of Broken Stone Railroad Ballast," "The Relation Between the Physical Properties of Rock for Road Building," and "Gravel and Broken Stone, Qualities, Testing, and Selection for Road Building"; also "The Physical Properties of Rock for Road Building," Office of Public Roads Bulletin 44.

Assignment.—Prévost Hubbard, F. H. Jackson, jr.

Proposed expenditures, 1916-17.—\$2,112.

Instrument Making and Repairing:

Object.—To build and keep in repair testing machines and instruments required in conducting road-material investigations.

Procedure.—Machines and instruments used in the testing of road materials and for other purposes in connection with other activities of the office are constructed and kept in repair.

Location.—Washington, D. C.

Date begun.—1893.

Results.—Various testing and engineering instruments have been designed, constructed, and repaired by this office.

Assignment.—E. B. McCormick, E. C. Glascock.

Proposed expenditures, 1916-17.—\$6,072.

Standardization of Methods of Testing Bituminous Road Materials:

Object.—To revise current methods of testing bituminous road materials or develop and introduce new and better methods.

Procedure.—Certain work is undertaken as an assignment by the committee on standard tests for road materials of the American Society for Testing Materials. Proposed tests which appear in technical literature are investigated for the purpose of determining their value, and new tests are devised.

Cooperation.—American Society for Testing Materials.

Location.—Washington, D. C.

Date begun.—1905.

Results.—(1) During 1916: Department Bulletin 314, "Methods for the Examination of Bituminous Road Materials," has been prepared and published; also a paper entitled "A New Penetration Needle for Use in Testing Bituminous Materials," Journal of Agricultural Research, vol. 5, No. 24. As a result of an investigation of the penetration test, an article entitled "The Effect of Controllable Variables upon the Penetration Test for Asphalts and Asphalt Cements" has also been published in the Journal of Agricultural Research, vol. 5, No. 17. Other investigations have been conducted having the following purposes in view: Development of a new method for determining paraffin scale; improvements in the fixed carbon determination; the use of ether as a solvent for bituminous materials instead of naphtha; a toughness test for

Standardization of Methods of Testing Bituminous Road Materials—Cont'd
bituminous materials; a standard method of counting ultramicroscopic particles in solutions of bituminous materials.

(2) Prior to 1916: An article entitled "Methods for the Examination of Bituminous Road Materials" was published as Office of Public Roads Bulletin 38; also the following papers in proceedings of scientific societies and in technical journals: "The Examination of Bituminous Road Binders," "The Determination of Soluble Bitumen," "A Useful Form of Pycnometer for Determining the Specific Gravity of Semi-Solid Bitumens," and "Application of the Dimethyl Sulphate Test for Determining Small Amounts of Petroleum or Asphalt Products in Tars."

Assignment.—Prévost Hubbard, C. S. Reeve, F. P. Pritchard, B. A. Anderton.

Proposed expenditures, 1916-17.—\$2,532.

Standardization of Methods of Testing Nonbituminous Road Materials:

Object.—To standardize physical methods of testing nonbituminous road materials, so that the results obtained by various laboratories may be compared.

Procedure.—Standard methods of testing are obtained by studying in detail various methods in common use, for the purpose of determining the one which will give the most accurate and trustworthy results.

Cooperation.—American Society for Testing Materials and American Association of Portland Cement Manufacturers.

Location.—Washington, D. C.

Date begun.—1893.

Results.—(1) During 1916: A description of methods for the determination of the physical properties of road-building rock was published as Department Bulletin 347. A paper on "The Determination of the Specific Gravity of Non-Homogeneous Aggregates" was also presented before the American Society for Testing Materials. In addition, investigations have been conducted on the standardization of an abrasion test for gravel; a method of determining clay in aggregates; a method of determining the weight per cubic foot of sand; comparison of rational and ordinary sand sieves; a method for determining the normal consistency of cement mortars; and the determination of voids in aggregates.

(2) Prior to 1916: The office developed or perfected a number of tests for rock, such as the toughness test, the abrasion test, the hardness test, and the cementation test. Both the toughness and abrasion tests have been adopted as standard by the American Society for Testing Materials.

Assignment.—Prévost Hubbard, F. H. Jackson, jr.

Proposed expenditures, 1916-17.—\$1,131.

[Extension.]

(**Instruction of Students in Highway Engineering:** Project discontinued. See statement relative to similar project under "Road Management.")

Total, Road-Material Investigations, \$49,699, including \$11,919 statutory.

[Research.]

FIELD EXPERIMENTS.

Supervision:

Object.—To administer the various subactivities under this group and conduct routine office work.

Location.—Washington, D. C.

Date begun.—1911.

Assignment.—Vernon M. Peirce, E. B. McCormick, E. W. James, Prévost Hubbard.

Proposed expenditures, 1916-17.—\$2,240.

Experimental Road Construction:

Object.—To determine by experimentation the relative merits and values of various preparations and materials for use in road construction and of the various methods and types of road construction.

Procedure.—A section of road is selected and certain experimental construction determined upon. Arrangements are then entered into with the local authorities looking to cooperation in the expense of construction, this office retaining the right to carry out the experiments decided upon, both in the matter of con-

Experimental Road Construction—Continued.

struction and of maintenance. Short sections of road are then constructed, extending over the entire portion, each section being an experiment in itself, designed to determine the relative merits of certain road materials and the best methods of using the same in road construction.

Cooperation.—County and State officials in legal control of the roads.

Location.—Montgomery County, Md., and Alexandria and Fairfax Counties, Va.

Date begun.—1911.

Results.—(1) During 1916: An experimental road $4\frac{1}{2}$ miles in length was built in 1916 in Alexandria County, Va., known as "Mount Vernon Avenue," and another $1\frac{1}{2}$ miles in length was built in 1916 in Alexandria County, Va., known as the "Russell road." The Russell road consists of seven different experiments, four of which are for the purpose of determining the relative slipperiness of roads constructed of tars and asphalt and to determine the practicability of using an asphalt seal coat on bituminous macadam roads having a tar binder; and the other three are experiments with the use of bituminous materials in gravel road construction. The Mount Vernon Avenue road comprises 20 experiments to determine the relative value of different kinds of stone and asphalt used with different kinds of bituminous materials, and also the practicability of using bank-run gravel as an aggregate in bituminous concrete.

(2) Prior to 1916: Bituminous macadam, water-bound macadam (surface treated with various organic and inorganic materials), bituminous concrete, Portland cement concrete (plain and surface treated), and brick roads have been built and maintained. Complete descriptions of this work have been published in circulars from year to year. Many highway engineers have visited these roads and have received valuable information. Information as to the relative values of the various materials is being secured.

Assignment.—Vernon M. Peirce.

Proposed expenditures, 1916-17.—\$30,790.

Traction Tests:

Object.—To determine the effect of width of tire, diameter of wheel, type and size of axle bearing, kind of power, and method of application of power on tractive effort required to haul vehicles over various types of road surfaces; to obtain comparative data on the resistance offered to traction by unimproved and improved road surfaces and by grades in the case of automobiles and horse-drawn vehicles; and to obtain data on the comparative pulling power and sustained effort and its relation to the rations of light and heavy draft animals.

Procedure.—Requests are being received from time to time by the office in regard to details of designs for wagons, the efficiency of improvement of road surfaces and its relation to grades, the capacity for sustained effort of draft animals, and class of work for which the different road types are best adapted.

Location.—Washington, D. C., and post and experimental roads throughout the United States.

Date begun.—1913.

Results.—(1) During 1916: Final tests have been made on post roads in Virginia, Maine, Maryland, Ohio, Mississippi, Texas, and South Carolina. Preliminary test has been made on the post road in North Carolina. Preliminary reports have been completed for Iowa, Alabama, Maryland, Virginia, Maine, Ohio, and Mississippi projects. A general report covering these projects is in course of preparation.

(2) Prior to 1916: Original and final tests had been made on post roads in Iowa (Ames) and Alabama and preliminary tests in Iowa (Dubuque), Maryland, Mississippi, Texas, South Carolina, Maine, Ohio, and Virginia.

Probable date of completion.—Two years.

Assignment.—E. B. McCormick, L. L. Beebe.

Proposed expenditures, 1916-17.—\$6,870.

Experimental Road Maintenance:

Object.—To conduct experimental maintenance to secure accurate cost data for various types of roads.

Procedure.—Under specific appropriations this office constructs certain experimental roads. These have been built in Montgomery County, Md., and Alexandria County, Va., and a second one in Alexandria County, Va., is in course of construction. To determine the relative value of various types of construction, maintenance of the built roads is necessary over a period of five years or more. This maintenance is conducted by the office with funds from the specific appropriation for field experiments.

Experimental Road Maintenance—Continued.

Cooperation.—Road authorities in Montgomery County, Md., and Alexandria County, Va., and the Bureau of Plant Industry.

Location.—Alexandria County, Va., Montgomery County, Md., and the Department of Agriculture grounds, Washington, D. C.

Date begun.—1907.

Results.—(1) During 1916: Accurate data have been secured covering the cost of maintenance of dirt, gravel, and bituminous macadam roads. Reports for the past year's work are to be published in the "Annual Progress Report for 1915" and technical publications. A large amount of very accurate information is being collected, which will be used in establishing a definite relation between the amount of traffic and the cost of maintaining various types of road surfaces. If these studies, supplemented by the traffic observations being taken in different counties throughout the country, can be continued, the result will make a decided and valuable advance in the practical elements of highway engineering. The selections of surface types for given conditions will then be based on accurate knowledge, instead of remaining a matter of loose judgment or guesswork, as at present.

(2) Prior to 1916: Although this project was begun in 1907, it was at first handled as a project to develop new or unusual road-building materials. Since January, 1913, the project has assumed a much more important aspect and is now so handled as to develop very exact comparable costs of constructing and maintaining modern roads of all types. The data secured in 1913-14 and 1914-15 indicated the possibility of correlating the amount of traffic and the cost of maintenance.

Assignment.—E. W. James.

Proposed expenditures, 1916-17.—\$21,290.

Road and Bridge Foundation Tests:

Object.—To determine the distribution of pressure through fills and foundations and to study the effect of loads on road surfaces and road foundations.

Procedure.—Concentrated loads will be applied on fills of different depths, and the intensity of distribution will be determined at various positions under the loads by means of specially designed weighing and loading devices. Studies will also be made on nonbituminous pavements and on concrete foundations of various thicknesses when placed on different types of sub-base and subjected to concentrated loads. In addition, it is proposed to study the effect of loads upon bituminous pavements constructed with various types and grades of bituminous material, which will be especially made for the purpose. Also in the field special apparatus will be buried in position for measuring soil pressure against various structures.

Cooperation.—Office of Public Buildings and Grounds, Washington, D. C., New York State Public Service Commission, and Department of City Transit, Philadelphia, Pa.

Location.—Washington, D. C., Arlington Farm, Va., New York, and Philadelphia, Pa.

Date begun.—November, 1915.

Results.—Apparatus has been devised and constructed for measuring the distribution of pressure through fills, and a paper describing such apparatus was presented before the American Society for Testing Material. A building especially designed for conducting these tests is under construction at Arlington Farm, and plans have been perfected for cooperative field experiments with various public-service bodies.

Assignment.—Prévost Hubbard, A. T. Goldbeck, E. B. Smith.

Proposed expenditures, 1916-17.—\$3,790.

Total, Field Experiments, \$64,980, including \$4,980 statutory.

FARM IRRIGATION INVESTIGATIONS.**Supervision:**

Object.—To supervise farm irrigation investigations and direct the editorial, clerical, and other routine work.

Location.—Washington, D. C.

Date begun.—1899.

Assignment.—Samuel Fortier.

Proposed expenditures, 1916-17.—\$11,450 (research, \$9,800; extension, \$1,650).

[Research.]

Utilization of Water in Irrigation:

Object.—To determine what constitutes the best utilization of water in irrigation, as to the quantity used and method of applying, to serve as a basis for irrigation practice, for designing canals, pumping plants, and farm ditches, for formulating ditch regulations and contracts, and for the granting and adjudicating of water rights.

Procedure.—In the arid region the utilization of water in irrigation has been studied in five ways: (1) The waste of water which is economically preventable, arising from absorption and percolation along the routes of porous channels and faulty distribution in lateral systems, has been determined and measures adopted with a view to effect a large saving in the appropriated water supply; (2) the quantity of water used and the area upon which it is used has been measured in a great many instances as a basis for more exact studies of what should be used; (3) different quantities of water have been applied to the same crop under similar conditions, to determine what quantity produces the best results under field conditions; (4) the application of water to fields by different methods and in different quantities, preceded and followed by soil-moisture determinations, to determine what part of the water used is retained by the soil within the root zone of plants and what methods give the most even distribution of moisture throughout the fields; and (5) tank experiments, in which exact determinations of the water used by crops at various stages of growth and the crops produced are made by periodical weighings. A field laboratory has been established during the past year at Denver, Colo., for tank and plot experiments on movement of moisture in soils and losses of moisture from soils by evaporation and percolation, and further investigations along these lines are being carried on with specially designed apparatus at various points in the Southwest. In the humid States, plants are designed for farmers, principally truck and fruit growers, who wish to undertake irrigation, and careful records of cost and returns are kept.

Cooperation.—States of Arizona, California, Nevada, and Wyoming under direct appropriations; in California, Colorado, Idaho, Kansas, Nebraska, New Mexico, Oregon, and Utah, under agreements with the experiment stations.

Location.—Salt River Valley, Ariz., Davis Farm and Sacramento and Imperial Valleys, Cal., Fort Collins, Colo., Twin Falls and Gooding, Idaho, Garden City, Kans., Lamaille and other valleys, Nev., Mesilla Valley, N. Mex., eastern Oregon, lower Rio Grande Valley, Tex., Cache Valley, Utah, Owl Creek, Little Goose Creek, and other typical stream valleys in Wyoming, and throughout the Eastern States.

Date begun.—1899.

Results.—(1) During the past year a report of cooperative work in Idaho covering five years was published by the department. A report on cooperative experiments covering two years' work at Billings, Mont., has been prepared and submitted for publication by the State. A report covering three years' cooperative work in Nevada has also been prepared but not yet presented for publication. Many of the data received are not conclusive and will be held and considered with the results of future work along the same line. In the East, advice has been given to many farmers and reports describing methods and giving results have been prepared.

(2) Prior to 1916: A large amount of data on duty of water and methods of irrigation has been published in former years.

Assignment.—Samuel Fortier.

Proposed expenditures, 1916-17.—\$39,270.

Pumping for Irrigation:

Object.—To investigate the adaptation of pumping machinery to supplying water for irrigation and to determine the cost of installation, maintenance, and operation of wells and pumping machinery. Most of the land of the Great Plains and much of that in other sections must be irrigated with water pumped from wells if it is ever reclaimed, and the small pumping plant supplying water to the individual farm is the most economical unit. Work of two kinds is needed in this field: (1) Technical investigations to work out improvements in the design of pumps for irrigation and (2) study of the operation of pumping plants in the field to secure a better adaptation of the equipment to the conditions under which it is working and to collect information as to the cost of installing and operating pumping machinery, in order to make it possible to advise farmers as to equipment and as to the practicability of obtaining a water supply by pumping under their conditions.

Pumping for Irrigation—Continued.

Procedure.—Mechanical tests are made under laboratory conditions and in the field to determine the mechanical efficiency of plants as a whole and of the pumps and engines. Records of the season's operation of pumps in use, including the time run, quantity of water pumped, quantity of fuel used, and cost of attendance, fuel, lubricating oil, and repairs, are kept by farmers, who are paid a small sum for keeping the records. Mechanical tests of the plants for which records are kept are made where possible. It is proposed to extend considerably for the next season the testing of pumping plants in use and the collection of information as to the cost of pumping under field conditions.

Cooperation.—California State Department of Engineering, University of California, Kansas, Nebraska, New Mexico, and Utah experiment stations, State engineer of Nevada, and Nevada State University, and Texas Agricultural and Mechanical College.

Location.—Vicinity of Los Angeles, Cal., Garden City, Kans., and vicinity, western Nebraska, Las Cruces, N. Mex., and several points in Nevada, Texas, and Utah.

Date begun.—1899.

Results.—(1) During the past year a general treatise on pumping for irrigation has been under preparation; also reports on pump tests in Kansas, on the operating costs of pumping plants in Nebraska, on tests of pumping plants in Idaho, and regarding a laboratory test of pumps.

(2) Prior to 1916: Several bulletins giving the results of pumping investigations have been published by the Office of Experiment Stations in the past. Data were published in O. E. S. Bulletins 181, 183, 191, and 201, and Farmers' Bulletins 277 and 394.

Assignment.—Samuel Fortier.

Proposed expenditures, 1916-17.—\$14,179.

Irrigation Appliances and Equipment:

Object.—To develop the best types of structures and equipment generally for diverting, transporting, dividing, distributing, and applying water used for irrigation. This will afford a basis for advising farmers as to improving present practices in regard to the kind of equipment to install.

Procedure.—This investigation consists principally of observing structures in use and studying their adaptation to the purposes which they are intended to serve, and the preparation of reports.

Cooperation.—University of California.

Location.—Throughout the United States. The nature of the work is such that it can not be localized, although much of it is done in the Eastern States, where irrigation is not generally practiced.

Date begun.—1899.

Results.—(1) During the past year the field work on chutes and drops has been carried on and manuscript reports on equipment for subirrigation and overhead spray systems prepared. Local investigations have been made at many points in the humid sections, and plans prepared.

(2) Prior to 1916: Many of the results of work of this kind have been published in farmers' bulletins in the past. More recently bulletins on gate structures (Department Bulletin 115), concrete linings for canals (Department Bulletin 126), and wood-stave pipe (Department Bulletin 155) have been published.

Assignment.—Samuel Fortier.

Proposed expenditures, 1916-17.—\$10,080.

Flow of Water for Irrigation in Ditches, Pipes, and Other Conduits:

Object.—To test the accuracy of formulas for the flow of water in conduits of various kinds and to work out new formulas, in order that conduits may be properly designed to carry the water which they are intended to convey.

Procedure.—Very careful and accurate measurements of the discharge of existing conduits are made, and from the results existing formulas are checked and new formulas developed.

Cooperation.—Reclamation Service.

Location.—Throughout the United States. As the observations are made on conduits already installed, the work is conducted wherever the desired kinds of conduits may be found.

Date begun.—1900.

Flow of Water for Irrigation in Ditches, Pipes, and Other Conduits—Cont'd.

Results.—(1) During the past year the results of measurements on open channels generally have been published in Department Bulletin 194; a report on the flow of water in wood-stave pipe has been submitted for publication, and a part of the field work for a report on the flow in concrete pipe has been done.

(2) Prior to 1916: Many data have been obtained but nothing was published until 1914. The results of measurements of flow in concrete-lined channels were published in Department Bulletin 126.

Probable date of completion.—1917.

Assignment.—F. C. Scobey.

Proposed expenditures, 1916-17.—\$6,740.

Measurement of Water for Irrigation:

Object.—To improve and standardize devices for measuring water for irrigation. The economical use of water and good agricultural practice require that the water used in irrigation be measured. Up to the present time no satisfactory means for measuring the small streams delivered to individual farmers have been devised, while the devices which are in use have not been accurately calibrated.

Procedure.—A hydraulic laboratory is maintained at Fort Collins, Colo., in cooperation with the Colorado Experiment Station, where the flow through various measuring devices is checked by volumetric measurements in carefully calibrated tanks. Discharge formulas and discharge tables are developed from the results of these experiments. New devices will be tested and experiments to develop more satisfactory methods made. At the Davis Farm of the University of California the discharges of the measuring devices used in that State and elsewhere are checked against standard weirs.

Cooperation.—Work in Colorado is done under cooperative agreement with the Colorado Experiment Station and that in California under agreement with the University of California.

Location.—Fort Collins, Colo., and Davis, Cal.

Date begun.—1899.

Results.—(1) Several reports of the work at the Fort Collins laboratory have been published by the department within the past year in the Journal of Agricultural Research and by the Colorado Experiment Station. Application for the public patent of a promising device developed at Fort Collins has been made. A report of work at Davis has been published by the University of California.

(2) Prior to 1916: In past years much information on this subject has been published in the bulletins of the Office of Experiment Stations.

Assignment.—V. M. Cone, Frank Adams.

Proposed expenditures, 1916-17.—\$6,580.

Customs, Regulations, and Laws Relating to Irrigation:

Object.—To determine the effect of customs, regulations, and laws upon the use of water by farmers under irrigation, upon the economical use of water from the standpoint of the public, and upon the success of irrigation development, and to suggest desirable changes. The fact that the supply of water for irrigation is limited and that it is practically impossible for a farmer to individually provide himself with a water supply for irrigation or to protect his water supply from being used by others has led to a high degree of public control over the use of water for irrigation and to an elaborate organization for providing a water supply. Irrigation practice is, therefore, controlled to a very large extent by customs, regulations, and laws, which have fully as large an influence on the success of the farmers under irrigation and on the best use of this limited natural resource as have physical conditions.

Procedure.—The operation and effect of the customs, regulations, and laws controlling the use of water for irrigation are studied through correspondence and through field employees, and reports based on the results of these studies are prepared.

Cooperation.—State Engineering Department of California, University of California, Utah Experiment Station, and State of Wyoming.

Location.—Headquarters at Washington, D. C.; work covers the entire country.

Date begun.—1899.

Results.—(1) During the past year a report on the operations under the irrigation district laws of the Western States was partially prepared, a report dealing with the districts in California has been prepared and published by the State, and reports on cooperative irrigation enterprises and the mutual water companies of southern California are in preparation. Studies of the extent and

Customs, Regulations, and Laws Relating to Irrigation—Continued.

character of public control of irrigation, of the limitations upon irrigation practice in regulations, contracts, laws, etc., and of the methods of financing irrigation enterprises have been begun.

(2) Prior to 1916: For several years after beginning irrigation investigations a large part of the work done was of the character outlined in this project, and a number of bulletins giving the results have been published, including Office of Experiment Stations Bulletins 60, 70, 100, 105, 130, 144, 168, 190, 192, and 229.

Assignment.—R. P. Teele.

Proposed expenditures, 1916-17.—\$10,240.

Drainage of Irrigated Lands:

Object.—The devising of methods for reclaiming lands which have been injured by overirrigation, by the rise of ground water due to irrigation, or by waste water from irrigation canals or irrigated lands, and the prevention of injury to irrigated lands from these sources; and the handling of general drainage problems in the sections where irrigation is practiced.

Procedure.—This work has been transferred from the Drainage Division to the Irrigation Division. The change is made largely in the interests of economical administration and efficient work. The prevention of injury to irrigated lands from water-logging and of the accumulation of alkali and the reclamation of such lands when injured are so closely allied as to constitute a single problem, and the placing of this work under one division will make it possible to obtain better results. Experiments to determine the proper location, depth, and size of drains, the effect of relief wells in removing water under pressure, and the best methods of washing out alkali will be continued. In addition, efforts will be made to secure the transfer of water rights now used on low, wet lands to higher lands and the irrigation of the low lands with water pumped from the same or other low lands, thereby supplying lands now without water and improving the low lands. Attempts to prevent injury will be made by realigning canals, lining canals, revising systems of distribution, and encouraging the economical use of water.

Cooperation.—California, Colorado, and Utah experiment stations, Twin Falls (Idaho) Canal Co., and individuals.

Location.—Throughout the arid regions of the United States.

Date begun.—1903.

Results.—(1) During the past year Department Bulletin No. 190, "Drainage of Irrigated Lands," was published. A manuscript on the drainage of the Grand Valley, Colo., has been completed and distributed widely in mimeographed form. A report on "The Drainage of Shale Lands" has been submitted to the office with a view to publication; also a manuscript on "The Drainage of Irrigated Lands," which it is proposed to publish as a farmers' bulletin. To meet the needs of farmers in California a report has been prepared on "Farm Drainage in California," which it is proposed to have published by the California Experiment Station under a cooperative agreement with the department.

(2) Prior to 1916: Through the efforts of the department, the first drainage district in Arizona has been organized and bonds amounting to \$108,000 have been sold. Construction work is now in progress. Throughout the irrigated sections of the United States a large number of tracts which were almost unproductive have been made profitably productive by installing drainage systems in accordance with methods advocated by the department. It has been demonstrated that in the irrigated regions drains must be 5 to 8 feet deep to be effective. Under conditions not infrequently met with it has been determined that relief wells to a depth of 15 to 30 feet and deeper are necessary to supplement the drains.

Assignment.—Samuel Fortier.

Proposed expenditures, 1916-17.—\$12,140.

[Extension.]

Expert Advice and Assistance:

Object.—To assist in irrigation development and the improvement of irrigation practices by advising as to methods and equipment for irrigation.

Procedure.—A large part of this work consists of replying to letters asking for information or advice. In some instances, particularly in the East, engineers visit farmers, investigate their conditions, and give the necessary advice as to equipment and instructions for its installation.

Expert Advice and Assistance—Continued.

Cooperation.—State agricultural colleges through the States Relations Service, and owners of plants.

Location.—Headquarters at Washington, D. C.; work covers the whole country.

Date begun.—1899.

Results.—Several plants have been installed under the direction of this office and are in successful operation.

Assignment.—Samuel Fortier.

Proposed expenditures, 1916-17.—\$5,439.

Total, Farm Irrigation Investigations, \$116,118, including \$12,718 statutory (research, \$109,029; extension, \$7,089).

FARM DRAINAGE INVESTIGATIONS.**Supervision:**

Object.—Supervision of farm drainage investigations, including necessary clerical and other routine work, and the purchase of equipment and supplies not properly chargeable to specific projects.

Location.—Washington, D. C.

Date begun.—1903.

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$14,945 (research, \$7,473; extension, \$7,472).

[Research.]

Construction, Operation, and Maintenance of Drainage Improvements:

Object.—To study the cost and efficiency of machines and implements for digging ditches and building levees under various conditions of work; to study the sizes, types, and arrangement of pumping equipment suitable for drainage works; to investigate the strength and durability of tile, especially of cement tile in alkaline soils; to make a study of the cost of construction, operation, and maintenance of drainage improvements and an analysis of such costs; and to determine the rate of depreciation of drainage improvements.

Procedure.—Data are collected by correspondence and by personal inspection from manufacturers, owners, and operators of equipment, from officers of drainage districts, and from individuals.

Cooperation.—Bureau of Standards, Reclamation Service, and Association of American Portland Cement Manufacturers.

Location.—United States.

Date begun.—1903.

Results.—(1) During 1916: Department Bulletin 300, "Excavating Machinery Used in Land Drainage," Department Bulletin 304, "Land Drainage by Means of Pumps," and Farmers' Bulletin 698, "Trenching Machinery for Tile Drain Construction," were issued. Data have also been collected and are now in course of compilation for a bulletin on "Maintenance and Management of Drainage Improvements." Technologic Paper 44 of the Bureau of Standards, Department of Commerce, contains the results of the first year's tests relating to the durability of cement drain tile in alkaline soils.

(2) Prior to 1916: Department Bulletin 71, "Wet Lands of Southern Louisiana and Their Drainage," published.

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$11,700.

Drainage of Peat, Turf, and Muck Soils:

Object.—To study special problems involved in planning and constructing drainage systems for peat, turf, and muck soils.

Procedure.—Investigations will be continued to determine the amount of shrinkage or contraction of such soils after drainage improvements have been constructed. The relative advantages and disadvantages of open ditches and tile drains in such soils will be studied. Investigations will be made to determine the rapidity with which the excess water should be removed from such soils and the height at which the ground water must be maintained to provide sufficient moisture for profitable agriculture.

Location.—Southern Louisiana, Florida, North Carolina, South Carolina, New Jersey, New York, Ohio, Wisconsin, and Michigan.

Date begun.—1908.

Drainage of Peat, Turf, and Muck Soils—Continued.

Results.—(1) During the past year investigations were made in Ohio, New York, Florida, and southern Louisiana, which indicate that considerable contraction takes place after drainage. The data collected during the year in southern Louisiana are now being compiled with the view of furnishing the information in mimeographed form to persons interested in the reclamation of such soils.

(2) Prior to 1916: Data secured previous to 1910 received limited distribution in typewritten form; practically no further investigations made until the fiscal year 1914.

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$11,300.

Drainage of Tillable Lands:

Object.—To determine the proper depth, spacing, and arrangement of tile drains in various types of soils, the carrying capacities of tile drains, and the effect of drainage upon the soil temperature; to ascertain the amount of water that should be removed by tile drains per day from various kinds of soil under varying conditions of climate and topography; to investigate the effect of drainage on crop yields; and to determine the best methods of terracing to prevent washing and gulying of hillside farm lands.

Procedure.—Accurate data are obtained to compare the effectiveness of drains variously arranged in different kinds of soil, to compare drained with undrained land, and to compare conditions on the same tracts before and after drainage. Measurements of flow from farm-drainage systems are observed in connection with the degree of drainage afforded by the drains. The necessary observations are made on tracts selected for farm-drainage extension work. The tests commenced last year on the Arlington Experimental Farm (Virginia) to determine the capacities of tile drains at various slopes will be continued. In sections of the country where terracing has been practiced, studies of the various types have been made. A study will be made of various cement tile machines which have been placed on the market for the use of farmers in making tile on the farm.

Cooperation.—North Carolina Department of Agriculture, Alabama Experiment Station, and interested landowners.

Location.—Middle and South Atlantic States and lower Mississippi Valley; particularly Maryland, Alabama, North Carolina, West Virginia, and Kentucky.

Date begun.—1913.

Results.—(1) During 1916: Brief reports on the effect of tile drains on the ground-water level on an experimental tract in Montgomery County, Ala., have been distributed rather widely in mimeographed form. Similar reports have been made during the past year on tracts near Mount Jackson, Va., and Easton, Md. On the Arlington Experimental Farm (Virginia) tests have been made to determine the capacities of tile drains at various slopes.

(2) Prior to 1916: An article on "Economy of Farm Drainage," based upon data obtained in various States, has been published in the department Year-book for 1914. Standard instructions for the construction of tile drains, with illustrations of construction methods, have been widely distributed. In the black prairie belt of Alabama and Mississippi, before making investigations it was believed that these lands could not be drained unless the tile were spaced 40 feet apart and laid at a depth of 2 to 2½ feet. Investigations have shown that this soil can be well drained by spacing the tile 75 feet apart and laying them at a depth of 3½ feet. The investigations in Alabama alone have resulted in a saving to the farmers of about \$75,000,000.

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$15,180.

(Drainage of Irrigated Lands: Project transferred to Farm Irrigation Investigations.)

Organization, Financing, and Legal Regulations of Drainage Districts:

Object.—To study the organization of drainage districts and the laws under which such districts are formed; to investigate the various methods of financing drainage districts; to determine the effect of customs and drainage laws and regulations upon the economical organization of drainage districts; and to study the various methods of assessing costs of drainage improvements.

Procedure.—The work is conducted through correspondence and personal interviews with bonding-house officials, attorneys of drainage districts and bonding houses, and drainage district officials. Study will be continued of the reasons for the failure of drainage districts to meet their obligations and an effort made to ascertain the number of such failures. Advice will be given officials of proposed and

Organization, Financing, and Legal Regulations of Drainage Districts— Continued.

organized drainage districts in proper methods of procedure in organization and in disposing of securities to raise funds for the payment of improvements. An endeavor will be made to keep in close personal touch with districts from their inception, so that the greatest possible amount of authentic information may be collected. Addresses will be made at meetings of drainage associations and district officials on the subjects above mentioned.

Location.—United States.

Date begun.—1909.

Results.—(1) During 1916: Sufficient information has been collected on the organization of districts to enable the preparation of a report, which will be written in simple form as a farmer's bulletin, to indicate to the farmer methods of organizing drainage districts, as well as pointing out dangers to be avoided. Data have also been collected on financing of drainage districts, which will be compiled for a department bulletin.

(2) Prior to 1916: Drainage laws have been passed in Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Idaho, Utah, Washington, New Mexico, and Mississippi, in framing which representatives of the Division of Drainage Investigations have offered helpful suggestions.

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$4,800.

Run-Off Investigations:

Object.—To determine the rates of run-off which must be provided for by drainage channels in reclaiming wet lands and to determine the sizes of ditches necessary to remove the run-off.

Procedure.—Gaugings are made of the rates of flood flow from drainage districts of known areas. As this rate is greatly affected by rainfall, topography, character of soil and vegetation, season, and size and shape of the drainage basin with reference to the arrangement of the tributary watercourses, data are collected relative to these conditions. At favorable locations actual measurements are made of the size and shape of the channel, slope of the water surface, and quantity of flow, and the condition of the channel with respect to roughness and uniformity is noted.

Cooperation.—Geological Survey, Iowa Engineering Experiment Station, Ames, Iowa, and private engineers working in the vicinity where the investigations are being conducted.

Location.—Mississippi, Arkansas, Tennessee, Iowa, Idaho, Louisiana, South Carolina, and North Carolina.

Date begun.—1908.

Results.—(1) During 1916: Data representing several years' work in Missouri, Arkansas, Mississippi, Tennessee, and Louisiana have been compiled with a view to publication. Information on studies made in Mississippi and Louisiana has been distributed in form similar to previous years.

(2) Prior to 1916: Data collected in Illinois, Iowa, Louisiana, and Mississippi have been compiled and distributed in mimeographed form among engineers and persons interested in drainage reclamation.

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$9,800.

Drainage of Tidal Marshes:

Object.—To investigate the cause of failure in many attempts made to reclaim tidal marsh land, and to determine the proper arrangement and size of sluice openings and the requisite storage capacity of ditches.

Procedure.—Examinations are made of areas where attempts have been made to embank and drain such land, and studies of the methods and cost of the work and the benefits obtained are conducted.

Location.—During 1917 work will be conducted along the Atlantic and Gulf coasts.

Date begun.—1903.

Results.—No investigations made since the publication of Office of Experiment Stations Bulletin 240, "Tidal Marshes and Their Reclamation," except of a few small tracts near San Francisco and one tract along Puget Sound, Wash.

Reports were made and distributed in typewritten form to interested parties.

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$3,300.

[Extension.]

Drainage of Tillable Lands:

Object.—To teach landowners the proper methods of planning and constructing farm drains and terraces and to inform them concerning the benefits to be derived from such improvements.

Procedure.—From the request received for assistance representative farms which will serve as good demonstrations are selected, consideration being given to the location of the farm and the methods of farming practiced by the owner. A drainage or terrace system is designed and advice given during the construction of the system. In farming communities where farm drainage or terracing is not practiced meetings of farmers are addressed for the purpose of creating an interest in these forms of land improvement.

Cooperation.—Through the States Relations Service, with the colleges of agriculture of Alabama and Georgia; and with the North Carolina Department of Agriculture, representative farmers, and interested landowners.

Location.—Middle and South Atlantic States and lower Mississippi Valley, particularly Virginia, West Virginia, North Carolina, South Carolina, Georgia, Kentucky, Alabama, Maryland, Arkansas, and Missouri.

Date begun.—1903.

Results.—(1) During 1916: Results published in North Carolina Experiment Station Bulletins 234 and 236, "Farm Drainage in North Carolina" and "The Prevention and Control of Erosion in North Carolina, with Special Reference to Terracing." Bulletins are in course of preparation on tile drainage methods applicable to Virginia, Alabama, and South Carolina.

(2) Prior to 1916: Data published in Maryland Experiment Station Bulletin 186, "Land Drainage in Maryland." A large number of tile systems and terrace systems in North Carolina and Georgia have been installed by the landowners according to plans designed by this office. These systems are effective demonstrations of the benefits of drainage in increased crop yields as well as ease of cultivation and certainty of crops.

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$12,210.

Drainage of Overflowed Lands:

Object.—To promote interest in the reclamation of overflowed lands with the view of making them available for agriculture.

Procedure.—Surveys are made and plans prepared for the drainage of representative districts, selection of districts being made from requests received by the office. Meetings of interested landowners are addressed to explain the improvements needed and ways of organizing efficiently. In cooperation with the State Geological Survey of Georgia a reconnaissance survey of the State will be made to determine the area and location of wet and overflowed lands in that State.

Cooperation.—States Relations Service, individuals, communities, and proposed drainage districts.

Location.—Kootenai Valley, Idaho, Turkey Creek, S. C., Luxappalila River, Ala., Monona-Harrison Drainage District, Iowa, and a number of small streams in Missouri and the Piedmont sections of North Carolina, South Carolina, and Georgia.

Date begun.—1903.

Results.—(1) During 1916: Plans have been made and reports submitted in mimeographed form for the Panther Creek Drainage District in Kentucky (42,000 acres), Mayfield Creek Drainage District in Kentucky (25,000 acres), Monona-Harrison Drainage District in Iowa (69,200 acres), and the Luxappalila Drainage District in Alabama (22,300 acres), as well as for many smaller districts.

(2) Prior to 1916: Surveys and plans have been made and reports published on the Cypress Creek Drainage District in Arkansas (300,000 acres) and the Big Black River Drainage District in Mississippi (133,400 acres).

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$19,263.

Drainage of Swamp Lands:

Object.—To promote interest in the reclamation of swamp land with the view of making them available for agriculture.

Procedure.—Surveys are made and plans prepared for the drainage of representative districts. From the requests for assistance received by the office only those districts are selected which it is believed will serve as object lessons in swamp

Drainage of Swamp Lands—Continued.

reclamation. Meetings of interested landowners are addressed to explain the character of improvements needed and the methods which should be pursued in effecting an adequate organization.

Cooperation.—States Relations Service, individuals, communities, and proposed drainage districts.

Location.—Pleasant Grove Drainage District, Virginia; Cowcastle Swamp Drainage District, South Carolina; and Jefferson County, Tex.

Date begun.—1903.

Results.—(1) During 1916 most of the work on this project was of an advisory nature. Several districts in South Carolina which involve the reclamation of small areas were advised by a drainage engineer as to how to plan their drainage systems.

(2) Prior to 1916: Department Bulletin 193, "Report on the Drainage of Jefferson County, Texas" (612,000 acres), has been published. Surveys and plans have been made for the Cowcastle Swamp Drainage District, South Carolina and report disseminated among the interested parties. Engineers have conferred with the officials of Pleasant Grove Drainage District, Virginia, and many smaller districts, advising them how they might proceed with their work along proper lines.

Assignment.—S. H. McCrory.

Proposed expenditures, 1916-17.—\$6,975.

Total, Farm Drainage Investigations, \$109,478, including \$14,758 statutory (research, \$63,553; extension, \$45,925).

[Research.]

RURAL ENGINEERING INVESTIGATIONS.**Supervision:**

Object.—Supervision of rural engineering investigations, including necessary clerical, drafting, and other routine work and the purchase of equipment and supplies not properly chargeable to specific projects.

Location.—Washington, D. C.

Date begun.—1915.

Assignment.—E. B. McCormick.

Proposed expenditures, 1916-17.—\$2,700.

Investigations of Farm Domestic Water Supply and Drainage Disposal:

Object.—To improve the sanitary conditions of the farms of the country by making available to farmers a knowledge of proper systems of plumbing, water supply, and drainage disposal, and to assist them in installing systems suited to the existing conditions.

Procedure.—Investigations are made of the conditions upon the farms in the various sections of the country. Systems, devices, materials, etc., now in common use are studied, and such of these as may be found adaptable are applied to rural conditions. Designs are prepared for water-supply and drainage-disposal systems suited to various conditions. The information acquired is disseminated by means of bulletins, lectures, correspondence, distribution of blue prints, and by personal advice and consultation when feasible.

Cooperation.—Owners and users of object-lesson and experimental installations designed by this division.

Location.—Washington, D. C.

Date begun.—1915.

Results.—(1) During 1916: In addition to handling a large correspondence with individuals asking for assistance, there have been completed three disposal-plant designs. One has been installed and two are in the course of installation in the vicinity of Washington. A water-distribution system and sewage-disposal plant suited to conditions prevailing on water-front farms in Maryland has been completed. There are in course of preparation a water-supply system, a sewage-disposal system, and a design for a camp privy. Two bulletins are in the course of preparation, one on farm water systems and the other on farm sewage and waste disposal. During a period of three months investigations were made and lectures delivered in a number of Middle West and Western States.

Assignment.—E. B. McCormick, George M. Warren, A. D. Morehouse.

Proposed expenditures, 1916-17.—\$5,503.

Investigations of the Construction of Farm Buildings:

Object.—The preparation of drawings for all kinds of farm structures and equipment and for the general layout of the farmstead, with a view to make the work of the farm less arduous and the home life more attractive.

Procedure.—Conditions on farms of the various sections of the country are investigated. Designs are prepared for farm residences of varying costs, accommodations, and styles to fit the conditions in the several geographical divisions of the country. Barns, other outbuildings, and equipment suited to the different types of farming in each section are designed. The drawings are published as prepared, and when a number of designs have been acquired there will be issued descriptive catalogues. Blue prints are supplied to those contemplating building, bulletins, lectures, papers, etc., are prepared on subjects connected with the work, and a wide correspondence is conducted with private parties seeking assistance on questions pertaining to farm structures.

Cooperation.—Various bureaus of the department.

Location.—Washington, D. C.

Date begun.—1915.

Results.—(1) During the past fiscal year, at the beginning of which this work was begun, there have been prepared designs for five farmhouses, two general-purpose barns, two sheep barns, two sheep sheds, one hay shed, one poultry house, and one corncrib. A number of sketch designs for barns and other structures have been made, prints of which have been used in correspondence for their suggestive value. Two completed designs have been published in the department's Weekly News Letter, resulting in a heavy demand for working drawings.

A typical farmstead plan, suited to the cattle-feeding industry in combination with general farming in the Middle West, has been prepared, and a model of this layout is being constructed. Two bulletins are nearing completion. An investigation has been made of the swine industry on reclamation projects with a view to design equipment suited to the existing conditions.

In addition to the foregoing, 30 distinct pieces of work have been executed for other bureaus in the department, some being drawings for structures and apparatus designed and carried to completion entirely in the division, and some being the development and completion to designs originating in the office submitting them.

A very heavy correspondence with individuals seeking assistance on questions involved in farm structures and equipment has been handled.

(2) Prior to 1916: The law under which this project is being conducted was first incorporated in the agricultural appropriation act, Office of Public Roads section, for the fiscal year 1916. Some of the work now being done by the Division of Rural Engineering was formerly conducted under the project "Farm Structures" in the Office of Farm Management, Bureau of Plant Industry.

Assignment.—E. B. McCormick, M. C. Betts, W. Ashby.

Proposed expenditures, 1916-17.—\$12,453.

Investigations of Rural Engineering Problems Involving Mechanical Principles:

Object.—To investigate mechanical principles involved in various kinds of farm equipment with a view to standardization and the securing of data which will be of assistance to farmers in selecting equipment, and to design new equipment and apparatus.

Procedure.—Farm equipment in common use is investigated, methods of testing developed, standards established which will enable farmers to determine for themselves the type of equipment best suited to their needs, and new equipment designed. The information obtained is issued in the form of bulletins, papers, blue prints, and general correspondence.

Cooperation.—American Society of Agricultural Engineers, National Gas Engine Association, Association of Tractor and Thresher Manufacturers, Quartermaster Corps of the War Department, and Bureau of Chemistry.

Location.—Washington, D. C.

Date begun.—1915.

Results.—(1) During the past fiscal year there have been designed three devices for preventing or extinguishing grain-separator explosion fires. These have been tested with success.

Plans have been formulated and apparatus partially designed for testing the draw-bar horsepower of tractors. Steps have been taken looking toward the determining of horsepower required to operate various types of machinery

Investigations of Rural Engineering Problems Involving Mechanical Principles—Continued.

in use on farms; also to determine the drawing power of horses of different types.

There has been completed an investigation to ascertain the success met with in the use of denatured alcohol for heating, lighting, and power purposes.

The dynamometer used in traction tests on post roads has been rebuilt..

A large correspondence has been carried on, in which information has been furnished on the subjects of cement and concrete, electricity and electrical appliances, farm lighting plants, farm machinery and implements, fuels, gas engines, heat and heating, lighting systems, lightning arresters and rods, power development, pumps and pumping machinery, refrigeration, spraying outfits, and a number of miscellaneous subjects.

Assignment.—E. B. McCormick, L. L. Beebe, Elmer Johnson, A. M. Daniels, A. D. Morehouse.

Proposed expenditures, 1916-17.—\$5,653.

Total, Rural Engineering Investigations, \$26,309, including \$6,309 statutory.

OFFICE OF MARKETS AND RURAL ORGANIZATION.

GENERAL ADMINISTRATION.

General Administration:

Object.—Supervision of the research, extension, service, and regulatory work of the Office of Markets and Rural Organization, and the execution of the necessary administrative work connected therewith.

Location.—Washington, D. C.

Date begun.—1913.

Assignment.—Charles J. Brand, O. J. Field, R. V. Bailey, Caroline B. Sherman.

Proposed expenditures, 1916-17.—\$55,800, including \$36,300 statutory (research, \$33,000; regulation, \$11,000; service, \$10,000; extension, \$1,800).

[Research.]

MARKETING AND DISTRIBUTION.

Cotton Handling and Marketing:

Object.—To investigate the commercial processes involved in the handling, marketing, and utilization of cotton, in order to make recommendations as to improvements and economies; to conduct investigational work in connection with the organization of communities of cotton growers to market their product; and to make experiments regarding the advantage of growing cotton from pure seed in these communities.

Procedure.—Present methods of handling and marketing the cotton crop are investigated; assistance is given to cooperative organizations in handling and marketing cotton; studies are made to determine the value to growers of grading cotton before sale; experiments are made to ascertain the relative commercial value of pure-bred varieties of cotton and the percentage of moisture in cotton at the gins, compresses, and other concentration points. Primary market surveys are undertaken to determine geographical production, the quality and variety of long-staple cottons, the possibility of a uniform tare for cotton bales, and other matters.

Cooperation.—Informal cooperation with the Office of Extension Work in the South, States Relations Service, the Bureau of Plant Industry, and several agricultural and mechanical colleges of the South.

Location.—Washington, D. C., and field investigations in all of the cotton-growing States, particularly North Carolina, South Carolina, Arkansas, Oklahoma, and Texas.

Date begun.—1912.

Results.—(1) During 1916: During the fiscal year 1916 surveys were made of long-staple and Sea Island primary markets. In cooperation with the North Carolina Experiment Station, the study of market conditions, begun in 1915, was extended to include Edgecombe, Mecklenburg, Nash, Wilson, and Wayne Counties, and a market survey was conducted in towns adjacent to all of these counties. Assistance in the preparation and marketing of cotton was rendered to farmers' organizations at Scott, Atkins, Camden, and Little Rock, Ark., Gadsden, Ala., El Centro, Cal., and in the Salt River Valley of Arizona. Cotton was classed for producers before sale at Dillon, S. C., and at Sweetwater, Tex., a study being made to determine the reliability of samples drawn by ginners under the Texas permanent warehouse law. Publication: Department Bulletin 311, "The Handling and Marketing of the Arizona-Egyptian Cotton of the Salt River Valley."

(2) Prior to 1916: Definite assistance in handling and marketing cotton graded prior to sale was given to farmers' organizations at Scott, Atkins, and Little Rock, Ark., and at Mesa, Tempe, Glendale, and Chandler, Ariz. In 1913 there was conducted a primary market survey in Oklahoma; in 1914, a seed cotton survey, a survey of the primary markets of nine cotton States, and a survey of the Sea Island cotton market; and in 1915 a study was made of primary market

Cotton Handling and Marketing—Continued.

conditions in Edgecombe County, N. C., and the marketing of cotton was investigated in Texas and Oklahoma. Publications: Department Yearbook Separate 605, "Improved Methods of Handling and Marketing Cotton," and Department Bulletins 36, "Studies of Primary Cotton Market Conditions in Oklahoma," and 146, "Economic Conditions in the Sea Island Cotton Industry."

Assignment.—Fred Taylor, D. C. Griffith, C. E. Atkinson, C. F. Creswell, J. G. Martin, O. J. McConnell, J. H. H. Higginbotham.

Proposed expenditures, 1916-17.—\$22,400.

Cooperative Purchasing and Marketing:

Object.—To investigate cooperative and semicooperative associations formed for the purpose of marketing and distributing or purchasing farm products, and the purchase of farm supplies, and to discover the forms of organization and methods of management best suited for their use. (For demonstrations of types of organizations see "Extension and Demonstration Work.")

Procedure.—Plans for the future involve a continuation of work conducted in the past, which has consisted of surveys of communities of producers and consumers to determine the practicability of using cooperative methods of grading, packing, inspecting, marketing, and distributing or purchasing farm products, in the purchase of farm supplies, and in utilizing or selling by-products of the farm; and rendering assistance in the organization of cooperative marketing and purchasing societies. Personal visits are made to organizations in various sections of the country to study their form of association and method of transacting business, in order to suggest any necessary improvements.

Location.—Washington, D. C.; field work in various sections of the United States as required.

Date begun.—1913.

Results.—(1) During 1916: Assistance was rendered in organizing a cooperative marketing association of the asparagus growers in the vicinity of Ridge Springs and Trenton, S. C., in the formation of a large organization of cotton growers at Tarboro, N. C., and in the organization of many small associations in different parts of the country.

After a thorough investigation of conditions prevailing in the fruit industry of four Northwestern States, an organization of the fruit interests involved was perfected. This was done to coordinate the many resident selling agencies so that they could cooperatively gather crop and market information, improve the physical handling of their products and the conditions under which such products are transported and stored, and develop necessary markets or outlets, both domestic and foreign. This plan of organization is unique in that it provides for a uniform contract between the growers and selling agencies and a neutral governing body composed of representatives of the growers and selling agencies to supervise the fulfillment of this contract. This work was done by cooperation between this project and the project "Marketing Business Practice."

An investigation of various State cooperative organization laws has been made and a model bill drafted as a basis for legislation by various States to provide for the incorporation, control, and operation of cooperative purchasing and marketing associations. This bill offers the distinctive feature of providing for non-stock as well as capital stock organizations. Publication: Department Yearbook, 1915, "The Cooperative Purchase of Farm Supplies."

(2) Prior to 1916: Many of the results of the work of this project were those achieved in connection with the work described under the project "Marketing Business Practice," which for the greater part of the fiscal year 1915 constituted a branch of this project. Assistance was rendered to cooperative organizations in all parts of the country, and practical surveys were made of producing communities for the purpose of assisting farmers to improve their marketing methods and to organize. This office cooperated with the Colorado Fruit Growers' Auxiliary Committee in devising a plan for the general improvement of conditions in handling and marketing the Colorado fruit crop. A card index of approximately 11,000 farmers' associations was compiled. Publications: Department Yearbook Separate 637, "Cooperative Marketing and Financing of Marketing Associations," Farmers' Bulletin 656, "The Community Egg Circle," and Department Bulletin 302, "Apple Market Investigations, 1914-15."

Assignment.—C. E. Bassett, C. W. Moomaw, O. B. Jesness, John C. Skinner.

Proposed expenditures, 1916-17.—\$26,420.

Market Surveys, Methods, and Costs:

Object.—To make comprehensive and detailed studies of the origin, movement, distribution, and consumption of market supplies of farm products, especially fruits and vegetables, in order to accumulate and disseminate useful information relating to all phases of the subject, including available and prospective production; movement of products into storage; foreign shipments or consumption; the various agencies by and through which farm products are handled, distributed, stored, and sold; costs of doing business through existing market channels; methods of inspection in vogue; the value and practicability of an inspection service, and other matters. (See "Collecting and Distributing Market Information.")

Procedure.—Information is accumulated to show the areas of surplus production of specific crops, dates within which certain areas move crops, usual markets to which crops are shipped, volume of movement in previous years, and tendency to increase or decrease production. Study is made of market methods, whether by consignment, f. o. b. sales, or sales through private distributing organizations. At certain consuming centers accurate records are kept of receipts and prices of specific products, while sample shipments are traced from producer to consumer, an itemized account being kept of all charges, costs, profits, and losses. Investigations are conducted relative to storage holdings of perishable products, sales of farm products through auction companies, and the cost and efficiency of existing inspection services.

Cooperation.—Informal cooperation with the Bureau of Crop Estimates.

Location.—Washington, D. C.; in about 20 of the larger markets in the country; and in the most important shipping areas of the various perishable products, in succession.

Date begun.—1913.

Results.—(1) During 1916: Experiments were conducted regarding the cost, practicability, and value of a comprehensive market news service for fruits and vegetables by rendering a service on strawberries, tomatoes, peaches, and cantaloupes, which demonstrated its practicability. Monthly reports showing the holdings of apples in cold storage were continued, and a survey was made of the distribution of the Northwestern boxed apple crop. A tabulation was made of the number of carloads of the commodities mentioned above which were unloaded in the 20 principal markets for consumption during 1915. These data will be used as a basis for determining per capita consumption. Publications: Department Bulletins—290, "Rail Shipments and Distribution of Fresh Tomatoes, 1914"; 298, "Peach Supply and Distribution in 1914"; and 315, "Cantaloupe Marketing in the Larger Cities with Carlot Supply, 1914."

(2) Prior to 1916: In 1915 monthly reports were issued showing the quantity of apples in cold storage, with comparisons with holdings of the same storages on the first of the previous month and in 1913. As noted above, this work was continued in 1916. Comprehensive lists of producers, growers' organizations, shippers, transportation agents, and others were compiled. Data were secured and compiled showing the commercial production and movement of tomatoes, peaches, and cantaloupes. Work preliminary to a news service on the apple and potato crops was done and a fairly complete news service rendered in 1915 on the strawberry and tomato crops. Publications: Department Bulletins—237, "Strawberry Supply and Distribution in 1914," 266, "Outlets and Methods of Sale for Shippers of Fruits and Vegetables," and 267, "Methods of Wholesale Distributions of Fruits and Vegetables on Large Markets."

Assignment.—W. A. Sherman, O. W. Schleussner, J. W. Fisher, jr., J. H. Collins, R. M. Peterson, H. F. Walker, Paul Froehlich, L. H. Martin.

Proposed expenditures, 1916-17.—\$36,380.

Market Grades and Standards:

Object.—To encourage and educate growers and shippers of fruits and vegetables properly to prepare their products for market, and to show them the vital need of fixed grades and standards for universal use, with a view to the ultimate national standardization of market grades, weights, measures, and packages or containers. (For demonstrations in proper methods of packing and grading perishable fruits and vegetables, etc., see "Extension and Demonstration Work.")

Procedure.—Careful studies are being made of the present efficient and inefficient methods of handling, grading, packing, shipping, and inspecting farm products. Existing types and sizes of boxes, baskets, hampers, crates, barrels, and other packages are being studied. These investigations should indicate the feasibility

Market Grades and Standards—Continued.

ity and relative desirability of grades and lead to the eventual establishment of standard grades and packages. The special study of the preparation and handling of boxed and barreled apples and of potatoes which was inaugurated in 1916 will be continued. Study has been commenced of the methods employed and the costs and results obtained by operators of community or central apple packing houses, in comparison with the costs and results obtained by individual growers in preparing apples for market. State and city laws concerning the grades, packing, containers, and marking of farm products are closely observed.

Location.—Washington, D. C., and in the producing sections and their markets.

Date begun.—1913.

Results.—(1) During 1916: The studies in producing sections of methods used in gathering, handling, grading, packing, and shipping perishable products have developed valuable information, which is being used in advising growers, shippers, and associations regarding the preparation and shipment of their crops. Temporary grades have been established for Arkansas sweet potatoes and Texas Bermuda onions. After further experiments with these grades, efforts will be made to have them generally accepted and established. This office has recommended and has assisted in obtaining the adoption of standard packages for certain products; also State and national legislation establishing standard grades and packages for a number of products. Publications: Farmers' Bulletins—703, "Suggestions for Parcel Post Marketing," 707, "The Commercial Grading, Packing, and Shipping of Cantaloupes," and 753, "Commercial Handling, Grading, and Marketing of Potatoes."

(2) Prior to 1916: Preliminary investigations were conducted which made possible the results shown under 1916. Many growers and shippers were advised as to the methods of grading and packing, and assistance was rendered in preparing legislation on standardization of grades and packages. Publication: Office of the Secretary Circular 48, "Marketing Maine Potatoes."

Assignment.—C. T. More, W. M. Scott, H. E. Truax, H. C. Hetzel.

Proposed expenditures, 1916-17.—\$24,640.

City Marketing and Distribution:

Object.—To investigate the distribution and marketing of farm products in cities, in order to determine and encourage the practice of the best methods and to extend advisory aid to city authorities and other interested persons in establishing economical and efficient marketing facilities.

Procedure.—Personal investigations are made of various municipal and privately owned public wholesale and retail markets offering points worthy of study, particular attention being paid to factors which will aid in the work of designing and estimating the costs of model markets of various types to answer the needs in different cities. Information with respect to these subjects is made available to cities that are interested in improving their marketing facilities, through visits by investigators or through correspondence and bulletins. Plans for work in 1917 involve a continuation of much that is now under way and include the designing of approved systems for the successful administration of public markets, together with model regulations; comparative study of service, prices, and overhead expenses of various agencies for retail distribution; study of city ordinances relating to the marketing and distribution of farm products, with a view to suggest improvements; and special investigations of the service rendered by and the proper regulation of the huckstering and pushcart systems in large cities. A study will be conducted regarding the losses which result from waste and deterioration due to the inefficient operation of established wholesale or retail agencies and their faulty locations with reference to transportation agencies, consuming sections, etc. In order to be of aid to growers and consumers when certain perishable products are in over-supply, connections will be made in many cities so that publicity campaigns may be instituted in times of emergency to facilitate distribution and to increase consumption.

Cooperation.—Office of Weights, Measures, and Markets of the District of Columbia (informal).

Location.—Washington, D. C., and in various cities throughout the United States.

Date begun.—1913.

Results.—(1) During 1916: Requests were received from a number of cities for aid in bettering their marketing facilities. Surveys were made in Memphis, Tenn., Cincinnati, Ohio, Lynchburg, Va., Hartford, Conn., Rochester, N. Y., and Battle Creek, Kalamazoo, Muskegon, Ludington, and Manistee, Mich., while advisory work was continued at several other points. In Huntington,

City Marketing and Distribution—Continued.

W. Va., a municipal wholesale and retail market has just been constructed economically in accordance with plans outlined by this office, and in Kalamazoo, Mich., a producers' public market was opened by the city on June 6 under an ordinance drafted by our investigators. During August, 1915, about 33,000 circular letters were sent out to retail fruit dealers located in 46 cities of 13 northern and eastern States, urging that they give wide publicity to the heavy supply of peaches and handle them under the modern methods outlined. Personal aid was given to this movement in New York and Pittsburgh. An inquiry on municipal public market activities in all cities of 10,000 population and over in this country has recently been completed and much valuable information obtained. Publication: *Farmers' Bulletin* 707, "The Commercial Grading, Packing, and Shipping of Cantaloupes."

(2) Prior to 1916: Since the project was begun in 1913, personal surveys have been made in about 20 cities located in 12 different States. In addition, many of the public markets located east of the Rocky Mountains have been visited in order to secure practical information regarding the factors which make for the success or failure of such institutions. Publication: Department Yearbook Separate 636, "Retail Public Markets."

Assignment.—G. V. Branch, Achsah Lippincott, R. McC. Beanfield.
Proposed expenditures, 1916-17.—\$14,180.

Transportation and Storage:

Object.—To investigate the service furnished throughout the United States by common carriers of every kind in the transportation of farm products, particularly perishables; to ascertain the need for more and better service in individual sections and in connection with particular commodities, and to cooperate with shippers in securing and with carriers in inaugurating such service; by comparisons of service, to elevate the standard of all; to inform carriers as to the greater needs of shippers in transportation service, and to bring shippers to a better understanding of their rights, duties, and joint responsibilities with the carriers in the safe transportation of their products to the consumer; to cooperate with shippers and carriers in a campaign of education for the use of better packages and better methods of harvesting, packing, and loading, so as to reduce the present great economic loss of foodstuffs in transit; to determine accurately the amount, kind, and location of all available public storage space in the United States, as well as its ownership and the rates charged for its use; to encourage the construction of more common storage houses on the farm, and to ascertain the relative quantity of the perishable foodstuffs of the country held in cold storage, the points at which it is so held and the relation of these points to producing sections, the length of time perishables are held, and the effect upon prices of holding them.

Procedure.—The character of transportation service furnished at the present time is ascertained from carriers, and from shippers is determined what additional service is desirable or necessary. By personal conference, correspondence, and through bulletins the question of standardization and improvement of service is approached. Through the same channels and through attendance at and participation in conferences of representatives of shippers and carriers, the desirability of closer cooperation between the two is emphasized, and stress is laid upon the necessity for eliminating economic waste in transit. Information respecting storage space, commodities stored, and commodity prices as affected by storage is secured as far as possible from the operators of storage plants, supplemented by data secured from other sources. Plans for work during 1917 will include further consideration of the feasibility of a "market-train" service in certain sections and additional investigations of the loss of foodstuffs in transit. Under this project necessary work is done to secure for the projects, "Market Surveys, Methods, and Costs" and "Marketing Live Stock, Meats, and Animal By-Products," statistics of the movement and distribution of live stock, fruits, and vegetables, and to secure from the carriers such daily telegraphic and other reports as will best aid in the work of directing the efficient distribution of perishable commodities.

Cooperation.—Bureaus of Plant Industry, Animal Industry, and Chemistry; Interstate Commerce Commission; associations of farmers and shippers; associations, bureaus, and committees of claim, and traffic, and other officials of common carriers.

Location.—Washington, D. C., and in the field.

Date begun.—1913.

Transportation and Storage—Continued.

Results.—(1) During 1916: This project secured from carriers a vast amount of statistical information regarding the movement and distribution of fruits and vegetables. Heretofore data of this kind have never been available in such detail as to be of any real value. Arrangements were made with the railroads for a resumption of the telegraphic reports inaugurated in 1915, and their cooperation was secured in the use of a specially designed postal card for reporting to this office the forwarding of each carload shipment of fruits and vegetables. Cooperation was had with carriers in an effort to reduce the loss of food-stuffs in transit, and material assistance was given in making more apparent to railway officials the value to the carriers of the work of the Department of Agriculture and the desirability of closer cooperation between the department and the carriers.

(2) Prior to 1916: The principal features of the work of this project prior to 1916 were an investigation of the transportation of milk in New England, an investigation of the different demurrage laws and regulations of the United States, and the consummation of arrangements with carriers for telegraphic reports of the movement of certain perishable commodities for use in the experimental market news service work. Publication: Department Bulletin 191, "Demurrage Information for Farmers."

Assignment.—G. C. White, T. F. Powell.

Proposed expenditures, 1916-17.—\$15,600.

Miscellaneous Problems in Marketing and Cooperation:

Object.—To enable the Office of Markets and Rural Organization to cooperate effectively with those governmental agencies already conducting investigations in the marketing of specific products; to develop foreign markets, where practicable, especially by a study of foreign methods and outlets; to take up the study of new lines of work relating to the organization of rural communities; and for investigations of the preparation, handling, preservation, and marketing of animal, food, and miscellaneous products not specifically provided for under other projects.

Cooperation.—Bureaus of Chemistry, Animal Industry, Plant Industry, and Crop Estimates, and the Forest Service; and Bureau of Foreign and Domestic Commerce, Department of Commerce.

Location.—Washington, D. C., and points in the field where necessary.

Date begun.—1914.

Results.—The principal activities under this project in 1916 were conducted in cooperation with other projects of the office. In 1914-15 work preliminary to the establishment of the projects, "Marketing Live Stock, Meats, and Animal By-Products," "Marketing Dairy Products," and "Marketing Grain, Seeds, and Hay," was done under this project. Publication: "Prices of Wheat to Producers in Kansas, etc.," House Document 1271, Sixty-third Congress.

Assignment.—Charles J. Brand.

Proposed expenditures, 1916-17.—\$13,400.

Marketing by Parcel Post and Express:

Object.—To determine the feasibility, both from a physical and economic viewpoint, of marketing farm products by parcel post and by express from producer to consumer direct, and to ascertain the best methods to be used. (For assistance in marketing farm products rendered to girls' canning clubs in the South, see "Extension and Demonstration Work.")

Procedure.—Experimental shipments are made with various commodities both to and from Washington. Employees in the field experiment in bringing producers and consumers into business contact for direct marketing. Field studies are made of the determining factors for the success or failure of parcel-post marketing campaigns conducted by postmasters in a number of cities.

Cooperation.—Post Office Department; Bureaus of Chemistry, Animal Industry, and Plant Industry, and the States Relations Service.

Location.—Washington, D. C., Chicago, Ill., Pittsburgh, Pa., and points in various other States and sections of the country as may be found feasible in the development of the work.

Date begun.—1913.

Results.—(1) During 1916: Field studies of parcel-post marketing were completed in Atlanta, Ga., Birmingham, Ala., New Orleans, La., Boston, Lynn, and Lawrence, Mass., Providence, R. I., and Baltimore, Md. These studies have shown that in none of these cities, with the exception of Boston and Lynn,

Marketing by Parcel Post and Express—Continued.

Mass., has parcel-post marketing been developed in what might be termed a commercial way. Publication: Farmers' Bulletin 703, "Suggestions for Parcel-Post Marketing."

(2) Prior to 1916: A study was made of shipping eggs by parcel post in lots of less than 15 dozen. Experimental shipments by parcel post were made with many commodities, including butter, more than 10,000 pounds of this foodstuff having been involved, and data having been accumulated for future publication. Publication: Farmers' Bulletin 594, "Shipping Eggs by Parcel Post."

Assignment.—Lewis B. Flohr, C. A. Burmeister, J. W. Law, C. C. Hawbaker.

Proposed expenditures, 1916-17.—\$16,060.

Marketing Live Stock, Meats, and Animal By-Products:

Object.—To conduct a thorough study of existing markets and methods of marketing live stock through the large central and small local markets, including transportation, yardage, sale, and delivery of live stock, and the slaughter, packing, and wholesale and retail distribution of meat products and by-products derived therefrom; classification and grading of live stock and meats; and other allied subjects, with the view of improving the methods and reducing the cost of marketing live stock, meats, and animal by-products. (For demonstrations in improving the methods of marketing live stock, meats, and animal by-products, see "Extension and Demonstration Work." See also "Market Reports on Live Stock and Meats.")

Procedure.—Plans for 1917 include a continuation of a systematic survey of the live-stock markets of the United States to ascertain their facilities, sources of supply, demand, and other features; investigations regarding the shipment of stock to market; and a survey of the meat-packing industry in its relations to market conditions, prices, and movements of live stock and the distribution and prices of meats and animal by-products. The work also will include investigations regarding local marketing methods and facilities, such as cooperative live-stock shipping associations, farmers' cooperative packing houses, municipal abattoirs, local marketing of live stock in the South, marketing of farm-prepared meats; and studies of commercial conditions affecting live stock and meat marketing, market classes and grades of live stock and meats, State and sectional marketing problems and conditions, and other subjects.

Cooperation.—Bureaus of Animal Industry, Plant Industry, Chemistry, the Forest Service, and the State Relations Service, Universities of Louisiana, Tennessee, and Arkansas, and the Commissioner of Agriculture of Vermont.

Location.—Washington, D. C., Baton Rouge, La., Knoxville, Tenn., Little Rock, Ark., St. Albans, Vt., and other points throughout the United States as required.

Date begun.—1914, as a part of the project "Miscellaneous Problems in Marketing and Cooperation."

Results.—(1) During 1916: An investigation of the organization, facilities, and methods of centralized live-stock markets of the United States has been conducted and arrangements effected with all of the principal stockyards for monthly reports of their live-stock receipts and shipments. The marketing of live stock in the South, the organization and methods of cooperative live-stock shipping associations, and the farmers' cooperative packing-house movement have been investigated. The municipally owned abattoirs in the United States have been subjected to systematic study with reference to local market conditions. A conference and hearing relative to the marketing of live stock and distribution of meats was conducted by direction of the Secretary on November 15 and 16, 1915, at Chicago under the chairmanship of the chief of the Office of Markets and Rural Organization. This was the first attempt that ever has been made to bring together representatives of the various interests concerned, and the official record of the meeting is a valuable contribution to the literature on this subject. A special investigation of the marketing of live stock in Colorado and Wyoming was made at the request of officials and organizations in those States, and a report was submitted to the governor in each instance. Investigations relative to methods and costs of marketing live stock and meats which were begun in 1914 under a plan of work outlined by the committee on the meat situation have been continued. Publications: Farmers' Bulletin 718, "Cooperative Live-Stock Shipping Associations," House Document 855, "Proceedings of the Conference Relative to the Marketing of Live Stock, Distribution of Meats, and Related Matters," and press bulletin, "Farmers' Packing Houses" (July 5, 1915).

Marketing Live Stock, Meats, and Animal By-Products—Continued.

(2) Prior to 1916: A comprehensive report entitled "Methods and Costs of Marketing and Slaughtering Meat Animals and Marketing and Distributing Meat Products and By-Products," was prepared. Special investigations were made relative to market conditions, especially as affected by quarantine due to foot-and-mouth disease, retail market prices at Providence, R. I., and marketing live stock in Louisiana, with especial reference to the New Orleans market.

Assignment.—Louis D. Hall, F. M. Simpson, S. W. Doty, Wallace V. Smith, Charles V. Whalin, Turner Wright, Lawrence Foot.

Proposed expenditures, 1916-17.—\$32,400.

Marketing Business Practice:

Object.—To investigate the business practices of cooperative and farmers' marketing, distributing, purchasing, and rural business organizations and other marketing agencies, with special reference to their accounting systems and methods of auditing, business organization, and financing, and to devise suitable methods of business practice and accounting systems for these organizations and agencies for the purpose of increasing their efficiency. (Demonstrational activities are described under "Extension and Demonstration Work.")

Procedure.—Plans for 1917 include the continuation of investigational work relating to the business methods employed in handling agricultural products on a commission basis and the perfecting of a uniform system of accounts for this business; work in devising and perfecting a uniform system of accounts and account sales for the agencies handling and selling fruit and vegetable products in the Pacific Northwest; the perfecting of a uniform system of accounts for cheese factories; and the perfecting of a system of business practice for cotton-classing organizations and warehouses. Information as to costs of doing business will be gathered from agencies using the Office of Markets and Rural Organization uniform systems of accounts, and from these data a set of average costs will be established for use as a guide to various types of agencies and as a basis for perfecting economies in operations. A study will be made of modern merchandising methods, such as advertising, salesmanship, etc., as applied to the marketing of agricultural products. Workers on the project will act wherever practicable in an advisory capacity to individual farmers and marketing and distributing agencies throughout the United States who desire to improve their business practice.

Cooperation.—Oregon Agricultural College, University of Minnesota, North Dakota Agricultural College, Bureau of Animal Industry (Dairy Division), Fruit Growers' Agency (Inc.), and various grain elevators, warehouses, fruit and produce exchanges, creameries, cheese factories, commission houses, etc.

Location.—Washington, D. C., and various points in the field.

Date begun.—1913, as a part of the project "Cooperative Purchasing and Marketing."

Results.—(1) During 1916: Uniform systems of accounts for cooperative live-stock shipping associations, creameries, cooperative stores, independent grain elevators, and warehouses, and auxiliary records for lumber accounts in grain elevators were perfected and made available for use. To date over 650 marketing agencies have installed the uniform systems of accounts perfected by the office. Personal assistance was rendered a large number of marketing agencies in improving their business methods, especially farmers' cooperative elevators, creameries, fruit and produce associations, live-stock shipping associations, fruit and vegetable canneries, and cooperative purchasing societies. Extensive investigations of the business side of marketing the fruits and vegetables of the Pacific Northwest were carried on, and assistance was rendered in organizing the growers and selling agents of that territory into a central exchange known as the Fruit Growers' Agency (Inc.). This work was done by cooperation between this project and the project "Cooperative Purchasing and Marketing." Publications: Department Bulletin 362, "A System of Accounts for Primary Grain Elevators," Office of Markets and Rural Organization Document 2, "Lumber Accounting and Opening the Books in Primary Grain Elevators," and Department Bulletins 371, "Patronage Dividends in Cooperative Grain Elevators," 381, "A System of Records and Accounts for Cooperative Stores," and 394, "A Survey of Typical Cooperative Stores in the United States."

(2) Prior to 1916: Uniform systems of accounting for cooperative fruit associations, cooperative produce exchanges, farmers' elevators, and egg circles were perfected and made available for use. Publications: Department Bulletins—178, "Cooperative Organization Business Methods," 225, "A System of Ac-

Marketing Business Practice—Continued.

counting for Cooperative Fruit Associations," and 236, "A System of Accounts for Farmers' Cooperative Elevators."

Assignment.—W. H. Kerr, G. A. Nashtoll, J. R. Humphrey, Wallace W. Wright, B. B. Mason.

Proposed expenditures, 1916-17.—\$32,980.

Marketing Grain, Hay, and Seeds:

Object.—To investigate the primary and terminal marketing of grain, seed, and hay; including the cost of marketing, comparison of service rendered by independent and line elevators and cooperative selling and purchasing associations; future transactions and exchange practices, scalping, prices, market quotations, supply and demand, export trade, and related subjects, in order to suggest possible improvements and economies in marketing the grain, seed, and hay crops. (See "Grain Handling and Transportation Investigations," Enforcement of the United States Grain-Standards Act, p. 464.)

Procedure.—Field investigations are conducted regarding the methods of marketing grain, seed, and hay at producing centers and terminal and retail markets. A study is being made of marketing methods adapted to certain sections and conditions, including method of marketing special crops, such as the grain sorghums. Statistical information relating to prices and price fluctuations is being collected and compiled. Market reports relating to price quotations, supply and demand, and other market information has been furnished to certain producing territory where marketing facilities are limited.

Cooperation.—Bureau of Plant Industry, Bureau of Crop Estimates, and States Relations Service.

Location.—Washington, D. C., and points in the field as necessary.

Date begun.—1915; preliminary work was conducted under the projects "Transportation and Storage" and "Miscellaneous Problems in Marketing and Cooperation."

Results.—(1) During 1916: A general survey has been made of marketing grain at country points. A detailed study of terminal grain marketing is now in progress; special study of the methods of distribution and marketing in the Eastern and Southern States is being carried on; assistance has been given the Southern States in the marketing of the corn and oat crops and suggestions given the producers and shippers of grain sorghums in finding a market for their products.

(2) Prior to 1916: New work; activities carried on under the heading, "Miscellaneous Problems in Marketing and Cooperation."

Assignment.—George Livingston, W. A. Wheeler, K. B. Seeds, George C. Edler, Earl Chenault, A. R. Evans.

Proposed expenditures, 1916-17.—\$27,840.

Grain Handling and Transportation Investigations: (See Enforcement of the United States Grain-Standards Act, p. 464.)**Marketing Cotton Seed and Its Products:**

Object.—To investigate present methods of handling, marketing, and utilizing cotton seed and its crude products, with a view to suggest means whereby improvements may be made and economies effected, and to make studies regarding future trading, the establishment of standard grades, and the standardization of conditions under which cotton seed and its products are handled and stored.

Procedure.—Plans for future work involve experimental crushings to determine the efficiency of different kinds of equipment and methods of handling; studies of State and Federal laws regulating the cottonseed industry; the various methods of handling cotton seed on the farm, at the gin, in transit, and in storage, and the effect of these methods on the resulting product; the business organization of the cottonseed and oil industry, including buying and selling for future delivery, the organization and operation of cottonseed oil mills by cooperative producers, the domestic and foreign utilization of cottonseed products, and the special methods of preparation necessary to meet the requirements of various markets. The utilization of the machinery of cottonseed oil mills in expelling oil from peanuts may be investigated in connection with the other studies carried on under this project.

Cooperation.—Informal cooperation with the Bureaus of Animal Industry, Plant Industry, and Chemistry, cottonseed buyers, manufacturers of cottonseed oil, State officials, and others.

Location.—Washington, D. C., and points in the field as required.

Marketing Cotton Seed and Its Products—Continued.

Date begun.—1914, as a part of the project "Cotton Handling and Marketing."

Results.—(1) During 1916: Investigation was made of the methods of marketing the cottonseed crop, in which over 1,600 cottonseed samples were collected from a number of markets, each sample having been graded and its moisture content having been noted, together with other information. This survey showed variations and differences in prices paid on the same day, in the same and neighboring towns, primary markets and mill centers, and pointed the way toward the possibility of eliminating various wastes. Samples of 24 different varieties of cotton planted and cultivated on the same land, under similar conditions, were obtained and ginned. The lint was graded and its length of staple determined. The cotton seed obtained in this investigation is being analyzed in order to compare the value of the oil and nitrogen content. A study also was made of the use of various containers for handling cotton seed.

(2) Prior to 1916: A study was made of the operation of various cottonseed oil mills and general information relating to the subject of cottonseed marketing and utilization collected. Rules which were formulated by cottonseed crushers' associations, merchants' exchanges, etc., governing transactions in cottonseed products were collected and compiled, together with the rules prescribed for the grading of cotton seed. Recommendations were made by this office to various cottonseed crushers' associations, merchants' exchanges, etc., as to the consideration of moisture content as a factor in grading cotton seed.

Assignment.—H. T. Poe, Jr.

Proposed expenditures, 1916-17.—\$7,020.

Marketing Dairy Products:

Object.—To conduct a thorough study of the marketing of dairy products and dairy substitutes, including the agreements under which they are sold, the methods and costs of preparing dairy products for market, market grades and classification of dairy products, market quotations and quotation systems, market requirements, market conditions, marketing methods, marketing facilities, and related subjects, in order to suggest measures by which market conditions and marketing methods may be improved and the cost of marketing dairy products reduced. (For extension work in marketing dairy products, see "Extension and Demonstration Work.")

Procedure.—Descriptive and statistical information is being secured in surveys of the dairy producing sections and leading dairy markets of the United States. These surveys will be supplemented by more detailed studies of the various phases of the whole problem of marketing dairy products. In these studies, information and data will be obtained through correspondence, cooperating agencies, collaborators, and questionnaires, and also through personal investigations by marketing specialists and assistants of the office. Plans for 1917 include a detailed study of the marketing of milk and its distribution in cities; also of the organization and operation of marketing associations of milk and cream producers. A general survey and investigation will be made of the marketing of cheese in the United States, in which particular attention will be given to the quantitative production of domestic and foreign varieties within the various producing sections, the size and style of cheese packages, market quotations for cheese, the requirements of various markets, and methods of market distribution. Attention also will be given to the warehousing of cheese and also the export and import trade in cheese. When practicable, assistance will be given to communities in solving problems involved in marketing dairy products and in perfecting more efficient, economical, and equitable marketing methods.

Cooperation.—Bureau of Animal Industry, the New York State College of Agriculture, and the Commissioner of Agriculture of Vermont.

Location.—Washington, D. C., Ithaca, N. Y., St. Albans, Vt., and points in the field where dairy products are produced, distributed, or consumed.

Date begun.—1914, as a part of the project "Miscellaneous Problems in Marketing and Cooperation."

Results.—(1) During 1916: A survey of the butter markets of the South was conducted, in which the sources of butter supply and information regarding the requirements of the markets and methods of market distribution were obtained. A similar survey was made of the markets of the North Central and Atlantic States. Milk-marketing investigations were conducted in a number of cities in Massachusetts and at Detroit, Mich. Work has been inaugurated in the State of New York in studying the methods and costs of marketing and distributing milk, and information has been obtained regarding the organization of milk-producers' associations.

Marketing Dairy Products—Continued.

(2) Prior to 1916: These include a general survey of the operation of Minnesota and Wisconsin creameries, and studies of the facilities and cost for transportation in marketing Minnesota creamery butter, the shrinkage in marketing dairy products in the South, and other subjects.

Assignment.—Roy C. Potts, G. P. Warber, H. F. Meyer, Mogens Tolstrup.

Proposed expenditures, 1916-17.—\$19,080.

Cotton Warehousing Investigations:

Object.—To accumulate and disseminate useful information relating to the warehousing of cotton, insurance rates while in storage, and benefits, including better arrangements for financing, to be derived from conserving cotton in storage houses, the construction of different types of warehouses, and the relation of present methods and practices of compressing cotton to warehousing. During the present year the work of this project will be conducted in connection with that done under "Administration of the United States Warehouse Act."

Procedure.—Study will be made of the standards for cotton warehouses recommended by insurance underwriters' associations, including costs and adaptability. Special attention will be given to State warehouse systems and to cooperative storage companies, with the view of aiding such systems and organizations where possible. Investigations will be made to determine the relation of warehouse facilities to the financing of the cotton crop and the interest rates on money loaned on cotton, and the relation of the various methods and practices of compressing cotton to storage capacity, insurance rates, and economy in handling and transportation. Studies will be made in the entire cotton belt, and special attention will be given to representative sections.

Cooperation.—Informal cooperation with the States Relations Service, State experiment stations, colleges of agriculture, private individuals, commercial companies, insurance companies, and others.

Location.—Washington, D. C., all of the cotton-growing States, and places outside of the cotton belt where cotton is centered and held in storage.

Date begun.—Work conducted under "Cotton Handling and Marketing" from the institution of that project in 1913 to July 1, 1915; established as a separate project on the latter date.

Results.—(1) During 1916: Preliminary tests have been made to determine the practicability of grading cotton by gin samples by showing the feasibility and advantages of taking samples at the gin, thus avoiding the necessity of tearing the covering of the bales and eliminating much waste due to excessive sampling. These tests will be continued. A complete and exhaustive survey was conducted throughout the cotton belt to determine existing cotton-storage conditions. Investigations were made to determine the value accruing to warehouse receipts on account of the addition of a statement showing the grade of the cotton stored thereunder. The aid to financing offered by uniform warehouse receipts, including a statement of grade, has been demonstrated. Special attention has been given to the statements of accounting in use by various storage companies.

(2) Prior to 1916: Tabulations were made of the data secured in surveys showing the location, capacity, and other details regarding cotton warehouses in the United States. Publications: Department Bulletins—216, "Cotton Warehouses: Storage Facilities Now Available in the South," and 277, "Cotton Warehouse Construction."

Assignment.—R. L. Nixon, Roy L. Newton.

Proposed expenditures, 1916-17.—\$12,600.

Investigation of Foreign Markets for, and Development of Export Trade in, Farm Products:

Object.—To investigate foreign markets for American farm products and to assist so far as possible in the development of the export trade in these products: to continue investigation of the marketing of the farm products of the United States by studying the disposition of and the demand for that portion which is sold or consumed abroad, with a view to the development of our export trade in agricultural products; to assist in establishing and strengthening contacts between American producers and exporters and foreign buyers and consumers of farm products; to make surveys to determine the normal consuming capacities of representative foreign markets, the grades, kinds, and qualities of products demanded, the quantities on hand, and the competition encountered on different

Investigation of Foreign Markets for, and Development of Export Trade in, Farm Products—Continued.

crops and at various seasons; to investigate the handling of export products at both domestic and foreign seaboard; to study export shipping facilities with a view to determine what improvements are needed therein; to secure information regarding purchasing and marketing systems, cooperative and otherwise, which may be in operation by farmers and others in foreign countries; to determine the causes and, if possible, to suggest the remedies for dissatisfaction on the part of foreign buyers with the quality or condition of shipments of American farm products; and to investigate various special and general problems relating to the foreign marketing of the agricultural products of this country.

Procedure.—Under this project facilities will be provided for extending the investigations of the Office of Markets and Rural Organization into foreign countries. Much basic information will be secured from the exporters of the United States. Foreign investigations will be carried on through special representatives and collaborators and by utilizing, so far as possible, the consular service and the services of the trade advisers of the State Department. Problems first to be taken up will be those considered most pressing and those giving best promise of early results. Europe, South America, and China will receive special attention. Facilities for transporting American fruits and other agricultural products to European countries will be studied and also the demands of the foreign trade as to varieties, grade, and packing, the normal consumption of such products in the more important markets of Europe, the methods of conducting fruit sales in foreign countries, and the like. If possible, American producers will be assisted through reports upon trade opportunities for the foreign marketing of farm crops and grades, and the standards, requirements, trade customs, methods of packing containers, etc., preferred by buyers and consumers of various countries will be learned and reported to American producers and exporters. Purchasing and marketing methods and systems, cooperative and otherwise, which may be in operation by farmers and others in foreign countries will be carefully studied in order to secure information and suggestions for American producers in regard to factors which make for success or failure.

Cooperation.—Various bureaus of the Department of Agriculture; the consular service and trade advisers of the Department of State; Bureau of Foreign and Domestic Commerce, Department of Commerce; United States Chamber of Commerce; and interested growers' associations, trade organizations, shippers, and transportation companies.

Location.—Washington, D. C.

Date begun.—September, 1916.

Assignment.—Charles J. Brand, C. W. Moomaw.

Proposed expenditures, 1916-17.—\$10,000.

Total, Marketing and Distribution, \$311,000, including \$44,000 statutory and exclusive of \$18,000 lump-fund reserve.

[Service.]

COLLECTING AND DISTRIBUTING MARKET INFORMATION.

Collecting and Distributing Market Information:

Object.—To collect and distribute by telegraph, mail, or otherwise, timely information on the supply, commercial movement, disposition, and market prices of fruits and vegetables; to assist shippers in securing better distribution of perishable products. (See "Market Surveys, Methods, and Costs.")

Procedure.—A field force is being organized to cover in turn the most important producing areas of each fruit and truck crop immediately preceding and during its shipping season. Temporary and permanent branch offices have been established in some of the most important markets and consuming centers. Daily telegraphic reports are being obtained from common carriers of the number of cars of each crop shipped from certain producing areas, with destinations. These reports, together with the number of cars offered and prices prevailing on each of the principal markets, will be summarized for redistribution to producing districts, markets, and the press.

Cooperation.—Formal cooperation with certain States which will share with the Office of Markets and Rural Organization the salary and expenses of local

Collecting and Distributing Market Information—Continued.

assistance; Weather Bureau, and States Relations Service. Informal cooperation with a number of railroad companies, cooperative organizations, growers, shippers, and receivers of perishable products.

Location.—Headquarters, Washington, D. C.; branch offices in Philadelphia, New York, Chicago, Boston, St. Louis, Minneapolis, Pittsburgh, Buffalo, and Kansas City; temporary offices in other large markets and in certain producing sections of the United States.

Date begun.—July 1, 1916.

Results.—This project is new, preliminary work having been conducted under the project "Market Surveys, Methods, and Costs."

Assignment.—W. A. Sherman, O. W. Schleussner, J. H. Collins, R. M. Peterson, J. W. Fisher, jr., H. F. Walker, A. D. Gail, jr., C. W. Dunning, J. P. Klein, J. C. Gilbert, P. C. Isbell, J. W. Park, Irving J. Woodin, Roy D. Bailey, Edward D. Baker, George E. Engels, Howard P. Henry, Frederick W. Read, Julius Smith.

Proposed expenditures, 1916-17.—\$149,100, including \$12,500 statutory.

[Service.]

MARKET REPORTS ON LIVE STOCK AND MEATS.**Market Reports on Live Stock and Meats:**

Object.—To gather, compile, and publish, at such frequent intervals as will most effectively guide producers, consumers, and distributors in the sale and purchase of live stock, meats, and other animal products, information concerning the market prices and distribution of such products and on related subjects.

Procedure.—Information will be gathered from stockmen, live-stock associations, State live-stock and agricultural boards, common carriers, stockyards, commission firms, live-stock exchanges, slaughtering and meat-packing companies, and others relative to the number of head of marketable live stock, especially cattle, hogs, and sheep, in the principal live-stock feeding districts and growing sections; prices, receipts, and shipments of the different classes and grades of cattle, hogs, and sheep at live-stock market centers; prices of meats and meat food products, and the amounts of such products in storage; and other matters.

Representatives of the office will be stationed at the principal centralized live-stock markets and consuming centers for the purpose of forwarding daily to the Washington office information relative to commercial movements and prices of live stock and meats of various classes and grades; particularly market receipts of fat cattle, hogs, and sheep, and prices of same, wholesale prices of dressed beef, hog products, mutton and lamb, stocks of meat and provisions in storage, and, at stated intervals, retail prices of meats and meat products. Arrangements also will be effected with State and local live-stock associations and other organizations and individuals for the purpose of securing at regular intervals definite information relative to the numbers and condition of marketable animals of specified classes and grades in the principal live-stock growing and feeding sections; and from railroads, stockyards, live-stock exchanges, and otherwise advices concerning the reported movements of live stock from shipping points and arrivals at markets. Summaries of this information will be distributed for publication at stated periods, and suitable portions thereof will be wired to persons willing to pay the cost of such service and to make the messages available to the public by publishing, posting, or otherwise disseminating the information. In connection with the work, standard classes and grades of live stock and meats will be determined and steps taken toward the unification of such standards in different live-stock markets and consuming centers.

Cooperation.—Bureau of Crop Estimates.

Location.—Headquarters, Washington, D. C.; representatives to be stationed at the principal live-stock markets, such as Chicago, Kansas City, Omaha, and National Stockyards, and in certain producing areas of the United States.

Date begun.—1916.

Assignment.—L. D. Hall, F. M. Simpson, S. W. Doty, Charles V. Whalin, Wallace V. Smith, Turner R. H. Wright.

Proposed expenditures, 1916-17.—\$65,000.

[Research.]

INVESTIGATIONS AND DEMONSTRATIONS OF COTTON STANDARDS, AND COTTON TESTING.

Investigations and Demonstrations of Cotton Standards:

Object.—To make field and laboratory investigations and demonstrations of standards for the different grades, qualities, and conditions of cotton, and to investigate the ginning, grading, baling, stapling, marking, compressing, and tare of cotton. (The actual preparation and distribution of the cotton standards established under the provisions of the United States cotton-futures act is carried on under another project.)

Procedure.—Studies are made regarding the adaptability to trade conditions of the standards for grade of white cotton and those for tinged and stained cotton. Methods are being considered for determining the exact length of staple of cotton, with a view to prepare a standard for this quality. Necessary work is being done to complete the preparation of the standards for Arizona-Egyptian cotton. A further study will be made of the various grades, qualities, and conditions of cotton, with the object of establishing standards for cotton of perished staple, immature staple, and for gin-cut and reginned cotton and cotton linters. The physical effects of the various processes of ginning, baling, and compressing on the grade and fiber of cotton are being investigated. When practicable, the services of grading experts are furnished to communities of cotton growers in order to demonstrate and promote the use of the official cotton standards. This work is done in conjunction with the "Cotton Handling and Marketing" project. To the end that cotton quotations may be placed on a more uniform basis, grade and standardization demonstrations will be conducted in certain spot markets for cotton.

The investigational and clerical workers assigned to this project also assist with the projects formed to conduct work in the enforcement of the United States cotton-futures act and in field investigations in cotton handling and marketing.

Cooperation.—States Relations Service; cotton gins and growers, interior buyers, cotton brokers, factors, compresses, cotton mills, and agricultural colleges.

Location.—Laboratory work at Washington, D. C.; field work where necessary.

Date begun.—1907.

Results.—(1) During 1916: After detailed investigation and study, standards for tinged and stained cotton were officially promulgated on January 28, 1916. (A list of the standards so far promulgated may be found under "Enforcement of the United States Cotton-Futures Act: Preparation and Distribution of the Official Cotton Standards of the United States.") In order to preserve the integrity of the official standards, 25 sets of the white standards promulgated December 15, 1914, and 10 sets of each of the standards for tinges and stains promulgated January 28, 1916, have been stored in vacuum tubes. These tubes will be opened whenever necessary to check the accuracy of future work. Samples of long-staple cotton have been examined with a view to develop standards for length of staple.

(2) Prior to 1916: The standards which now represent white cotton were promulgated December 15, 1914, as the official cotton standards of the United States. Publication: Farmers' Bulletin 591, "The Classification and Grading of Cotton."

Assignment.—Fred Taylor, Harold C. Slade, A. D. Hudson, T. C. Adams, H. B. Richardson, Emil Schulze.

Proposed expenditures, 1916-17.—\$26,080.

Cotton Testing:

Object.—To ascertain the waste, tensile strength, and bleaching qualities of the different grades, classes, and varieties of cotton, in order to determine their commercial and spinning value and to demonstrate the results of such tests.

Procedure.—Spinning tests are being conducted in cooperation with textile schools in various localities and several of the large cotton manufactories in New England. These tests are made on the basis of the official cotton standards of the United States, representing cotton with staple approximately fifteen-sixteenths of an inch in length, purchased from representative sections of the cotton belt. The standard grades of Egyptian cotton grown in the Salt River Valley in Arizona, now in process of formulation, are being tested. After storage under suitable moisture conditions, these cottons will be run through the

Cotton Testing—Continued.

various manufacturing processes under similar mill conditions. The yarns manufactured will be tested for tensile strength; bleaching and mercerization experiments will be made on the raw cotton and finished yarn; and the true commercial value of the product will be obtained. Relative commercial values of the waste from each grade will be ascertained, the relative cost of manufacture being taken into consideration throughout the experiments. In cooperation with the Bureau of Plant Industry, tests will be made to determine the relative manufacturing value of cotton of wasty and irregular fiber and generally less than seven-eighths of an inch in length of staple as compared to cotton with longer staple.

Cooperation.—Pocasset Manufacturing Co., Fall River, Mass., New Bedford Textile School, New Bedford, Mass., and North and South Carolina Agricultural and Mechanical Colleges.

Location.—Spinning tests at Fall River and New Bedford, Mass., Raleigh, N. C., Clemson College, S. C., and in other localities; laboratory work at Washington, D. C.

Date begun.—1913.

Results.—(1) During 1916: In cooperation with the Federal Horticultural Board, tests have been made on foreign-grown cotton fumigated with hydrocyanic acid gas to destroy the larvæ of the pink bollworm. These tests have demonstrated that such fumigation does not damage the fiber of cotton. Comparative spinning tests have shown that the Egyptian cotton grown in the Salt River Valley of Arizona is practically of equal value to Sea Island and Egyptian cotton of similar grade and staple. Spinning tests on the official standards of white cotton of the grades Middling Fair, Good Middling, Middling, Low Middling, and Good Ordinary are now in progress. Publications: Department Bulletins—359, "Comparative Spinning Tests of the Different Grades of Arizona-Egyptian with Sea Island and Sakellaridis Egyptian Cottons," and 366, "Manufacturing Tests of Cotton Fumigated with Hydrocyanic-Acid Gas."

(2) Prior to 1916: The spinning tests described in the foregoing paragraph were begun in 1915 but were not completed until 1916. Tests comparing the qualities of certain selected upland long-staple varieties with those of certain well-established varieties grown in the Mississippi delta show the former to be superior in some respects. Publication: Department Bulletin 121, "Spinning Tests of Upland Long-Staple Cottons."

Assignment.—Supervisory committee: Fred Taylor and D. E. Earle; and W. S. Dean, G. H. Anderson, C. E. Coburn, J. J. W. Cooper, R. V. Hellams, C. E. Killingsworth.

Proposed expenditures, 1916-17.—\$34,680.

Total, Investigations and Demonstrations of Cotton Standards, and Cotton Testing, \$60,760, including \$12,760 statutory.

[Research.]

RURAL ORGANIZATION.**Rural Credit, Insurance, and Communication:**

Object.—To aid in solving problems relating to the organization of rural communities for the purpose of obtaining better credit, insurance, and communication facilities by the accumulation and dissemination of useful information relating to the various phases of the subject. (Field assistance in the work of organizing rural communities for credit and insurance improvement is described under "Extension and Demonstration Work.")

Procedure.—Field investigations, supplemented by returns from questionnaires, personal correspondence, and by the study of official and other records, are made of the following subjects: The existing successful agencies extending mortgage and personal credit to farmers; organized activity among farmers for credit improvement; financing the breeding, feeding, and marketing of live stock; the uses and abuses of store and machinery credit; the problem of farm finance on reclamation projects in the West; various crop liens and leasing and tenancy systems; legislation affecting mortgage and personal farm credit; the nature and extent of losses in agriculture and the facilities most helpful in reducing such losses or minimizing such risks; and how efficient facilities for agricultural insurance may be best established and conducted; and organization for the improvement of methods of rural communication, especially between farms and in relation to local markets.

Rural Credit, Insurance, and Communication—Continued.

Cooperation.—Informal cooperation with the Bureaus of Plant Industry, Animal Industry, and Crop Estimates, the States Relations Service, State agricultural colleges, various State departments, and local agencies.

Date begun.—1913.

Results.—(1) During 1916: Detailed information with regard to interest rates and other charges on farm loans in the several States has been obtained and tabulated. A statement regarding farm loan conditions and agencies in the United States was made before the subcommittee of the Congressional Joint Committee on Rural Credits, November 15 and 17, 1915. Special colored charts have been prepared showing interest rates, commissions, and other charges on farm loans and sources of such loans in each of the States. Comprehensive information relative to the nature and extent of the advancing business from merchants to farmers is at hand for the 10 cotton States and the tabulation nearly completed. Information has been given to a number of States and to Members of Congress regarding legislation affecting rural credits. A model form of articles of agreement for a farmers' credit exchange has been prepared. Extensive information has been gathered concerning plans of organization and methods of cooperation of farmers' mutual insurance companies in the United States. A model form of articles of incorporation and by-laws for farmers' mutual insurance companies has been completed. A model form of articles of agreement and by-laws has been prepared for mutual cyclone insurance companies. Studies of farmers' telephone companies have been continued and information furnished in connection with the organization of several companies. Publications: Office of the Secretary Circular 60, "Amortization Methods for Farm Mortgage Loans"; Department Bulletin 384, "Costs and Sources of Farm Mortgage Loans"; and Year-book Separate 675, "How the Department of Agriculture Promotes Organization in Rural Life."

(2) Prior to 1916: A statement on rural credits was made before the subcommittee of the House Committee on Banking and Currency, December 3 and 4, 1913. A memorandum of agreement for mortgage credit improvement among members of the Scott Cotton Growers' Association was prepared. A financial survey among farmers was made on the Truckee-Carson and Minidoka reclamation projects. Publications: Farmers' Bulletins 593, "How to Use Farm Credit"; and 654, "How Farmers May Improve Their Personal Credit."

Assignment.—C. W. Thompson, V. N. Valgren, L. E. Truesdell.

Proposed expenditures, 1916-17.—\$25,740.

Rural Social and Educational Activities:

Object.—To aid in the improvement of social and educational conditions in rural communities by the accumulation and dissemination of useful information growing out of the study of typical communities with reference to their social and educational needs, the work of their existing forms of organization, and the possibilities for improvement through organized activity; to investigate methods of encouraging social organization activities; and to study means of improving social, economic, and educational conditions of women and children through the work of women's rural organizations. (For demonstrational work in supplying suggested programs for local communities, see "Extension and Demonstration Work.")

Procedure.—In cooperation with State agencies, suggested programs are being supplied periodically to local organizations. Experimental studies are being made for the improvement of county and community fairs. Assistance is given in conducting local community surveys. A general survey of women's rural organizations is being made.

Location.—Washington, D. C., Orange County, N. C., Albemarle County, Va., and various points in Alabama, Tennessee, and other States.

Date begun.—1913.

Results.—(1) During 1916: A plan has been worked out for supplying suggested programs to local community clubs in Alabama. Community surveys of Orange County, N. C., and Albemarle County, Va., have been completed and the statistical data compiled. A report on experimental studies of county and community fairs has been submitted. A model form of articles of agreement and by-laws for rural community clubs has been prepared. Lists of national and local organizations of women interested in social and educational activities have been secured. Detailed information has been obtained and tabulated for one State with regard to the percentage of club membership living on farms,

Rural Social and Educational Activities—Continued.

methods of organization, and improvements in the community secured by organization.

(2) Prior to 1916: In Chilton County, Ala., experimental studies were conducted with organizations formed to obtain the services of a rural nurse and to promote community fairs, "get-together" days, clean-up campaigns, and the federation of local organizations for social and educational programs. Publications: Department Yearbook Separates—626, "The Organization of Rural Interests," and 632, "The Organization of a Rural Community."

Assignment.—C. W. Thompson, J. S. Moran, Anne M. Evans.

Proposed expenditures, 1916-17.—\$14,840.

Total, Rural Organization, \$40,580, including \$7,720 statutory.

[Research and Extension.]

STATE COOPERATION IN MARKETING WORK.**State Cooperation in Marketing Work:**

Object.—To enable the Department of Agriculture to cooperate effectively with the several States in the employment of agents to study methods of marketing and distributing farm products in various States; to encourage, guide, and assist in coordinating marketing activities undertaken by the various States; and to carry to the people of the States selected for such cooperation, by demonstration and otherwise, the results of the investigations of the department relative to marketing and distributing farm products.

Procedure.—This work will be carried on in cooperation with certain of those States which appropriate money for marketing purposes, through the employment of specialists or agents in marketing and such other assistants and facilities as may be necessary. These agents will maintain headquarters in the various States concerned, and their salaries and expenses will be borne jointly by the Federal Government and the States. As joint representatives of the two agencies, they will correlate and unify the marketing activities of both, making available to each the facilities and potentialities of the other. (See "Extension and Demonstration Work.")

Cooperation.—States Relations Service; the directors of extension in each State in which work may be undertaken, the State boards of agriculture, and other agencies connected with the work involved.

Location.—Selected States throughout the United States.

Results.—During 1916: Publication of Office of Markets and Rural Organization Document 3, "The Results of a Survey of State Marketing Activities throughout the United States." (This preliminary work was done under the project "City Marketing and Distribution.")

Date begun.—New appropriation available July 1, 1916; work actually begun in 1915 with appointment of Mr. Fred W. Hofmann for duty in South Carolina.

Assignment.—Charles J. Brand, William A. Schoenfeld, Fred W. Hofmann.

Proposed expenditures, 1916-17.—\$35,000.

[Extension.]

EXTENSION AND DEMONSTRATION WORK IN MARKETING AND DISTRIBUTION AND IN RURAL ORGANIZATION.**Extension and Demonstration Work:**

Object.—To carry, by demonstration, to the people in the United States useful information relating to the marketing and distributing of farm products and the organization of rural interests.

Procedure.—(1) Demonstrations in proper methods of packing and grading perishable fruits and vegetables for market will be conducted, when practicable, at points of production in cooperation with producers and shippers; also demonstrations of experimental or proposed grades; and demonstrations of methods employed by community packing houses in peach and boxed and barreled apple sections. This work has grown out of the activities conducted under the research project "Market Grades and Standards."

(2) Demonstrations of types of cooperative organizations for purchasing and marketing will be conducted, where deemed advisable, by assisting in the organization of communities of producers to handle, distribute, and market farm products, and in the formation of associations of farmers and consumers

Extension and Demonstration Work—Continued.

to purchase farm supplies. Suggestions and advice will be offered with regard to the improvement of marketing methods used by communities already organized. This work is the outgrowth of that conducted under the research project "Cooperative Purchasing and Marketing."

(3) Efficient systems of accounting and improved methods of business practice will be demonstrated and, when practicable, this office will assist in the installation of systems of accounts devised by it. This work is the outgrowth of the research work conducted under the project "Marketing Business Practice," and the object is to improve the business efficiency of farmers' cooperative and noncooperative marketing, distributing and purchasing, and rural business organizations and other agencies engaged in the marketing, distributing, and storing of agricultural products, with especial reference to their accounting systems, methods of auditing, financing, and general business practices. Syllabi are available for courses in primary elevator accounting and management and cooperative organization accounting and management. Others are in course of preparation.

(4) Field assistance will be given in the organization of communities for credit, insurance, and social improvement, and suitable forms of agreement, by-laws, and other blanks necessary for this purpose will be supplied. Advice will be furnished existing organizations with regard to improving credit, insurance, and social conditions. Similar work was done in the past under the projects "Rural Credit, Insurance, and Communication," and "Rural Social and Educational Activities."

(5) State follow-up systems, which supply local communities regularly with suggested programs on social and economic topics of community interest, will be supplied for the purpose of stimulating and encouraging local community discussion. The programs will be accompanied by paragraphed statements and references prepared with the assistance of proper State and Federal experts. Communities receiving these programs will be expected to report thereon periodically to a designated State official.

(6) Assistance will be rendered to the members of girls' canning clubs in 15 Southern States in marketing their products. Efforts will be made to ascertain by conferences with club members, State and county extension workers, and by other practicable or necessary means, the kind and quantity of products to be marketed, the available markets for these products both within and without the State concerned, and the market conditions to be met. Suggestions will then be offered regarding the best and most practicable methods of distributing such products. This work is conducted by the leader of the project "Marketing by Parcel Post and Express."

(7) When practicable, field agents will be located in certain States to cooperate with existing agencies in the conduct of extension and demonstration work relating to general or specific phases of handling, distributing, storing, and marketing farm products and the organization of rural interests. (See also "State Cooperation in Marketing Work.")

Cooperation.—States Relations Service, various State societies, agricultural colleges, etc.

Location.—Various States throughout the United States.

Date begun.—1915.

Assignment.—Charles J. Brand, C. E. Bassett, C. W. Moomaw, W. A. Sherman, W. H. Kerr, Louis D. Hall, C. T. More, C. W. Thompson, L. B. Flohr, Roy C. Potts, Fred W. Hofmann, Turner Wright, Lawrence Foot, Mogens Tolstrup, William A. Schoenfeld, D. J. Burleson.

Proposed expenditures, 1916-17.—No definite allotment is made under this heading, the expenses incurred being included in the amounts allotted to the individual projects under which the work is conducted.

ENFORCEMENT OF THE UNITED STATES COTTON-FUTURES ACT.**Administration:**

Object.—To supervise and direct the investigational and regulatory activities of the Office of Markets and Rural Organization in connection with the enforcement of the United States cotton-futures act and the rules and regulations of the Secretary of Agriculture thereunder, and to perform such executive and clerical duties as may be necessary in connection therewith.

Cooperation.—Office of the Solicitor, in matters involving points of a legal nature and questions of general policy, and the Treasury Department, in matters pertaining to the work imposed by the act upon that department.

Administration—Continued.*Location.*—Washington, D. C.*Date begun.*—August 18, 1914.*Results.*—Publications: Office of the Secretary Circular 46, "Rules and Regulations of the Secretary of Agriculture under the United States Cotton Futures Act of August 18, 1914," and amendments thereto; Service and Regulatory Announcements of the Office of Markets and Rural Organization.*Assignment.*—Charles J. Brand. Board of examiners: Charles J. Brand, Fred Taylor, D. E. Earle, D. C. Griffith, J. G. Martin, Hal Brown, O. J. McConnell, W. S. Dean, Harold C. Slade, R. L. Francis. Committee on final inspection: Fred Taylor, D. E. Earle, D. C. Griffith, Hal Brown, W. S. Dean, Harold C. Slade.*Proposed expenditures, 1916-17.*—\$50,530 (regulation, \$17,460; service, \$20,760; research, \$12,310).

[Regulation.]

Determination of Disputes:*Object.*—To hear and determine disputes as to the grade, quality, or length of staple of cotton tendered in settlement of future contracts made in compliance with section 5 of the cotton-futures act and referred to the Secretary of Agriculture under the terms of the act for determination of facts; and to draw up memoranda of conclusions upon which are based the Secretary's findings in cases of dispute.*Procedure.*—Under the United States cotton-futures act disputes as to the grade, quality, or length of staple of cotton tendered in settlement of future contracts may be referred by either party to the Secretary of Agriculture for his determination, by submitting a sample of each bale in dispute and filing the necessary papers relating thereto in accordance with regulation 2 of the rules and regulations of the Secretary of Agriculture. When these samples are received by the department they are opened and placed in a conditioning room until called for by the clerk to the examiners. They are arranged then in convenient order for the examiners, who have been designated by the Secretary of Agriculture to pass judgment upon and render a memorandum of their conclusions as to the facts in dispute. The findings of the Secretary of Agriculture are sent to the parties in dispute and have the effect of prima facie evidence in all United States courts. A memorandum of the charges assessed against each party is prepared and forwarded to them in accordance with the provisions of section 31, paragraph 2, rules and regulations of the Secretary of Agriculture.*Cooperation.*—Office of the Solicitor, in matters involving points of a legal nature, including the preparation of findings for the signature of the Secretary.*Location.*—Washington, D. C. Temporary headquarters may be established at various points in the United States should occasion require, as provided in the rules and regulations of the Secretary of Agriculture under the United States cotton-futures act.*Date begun.*—Preliminary work commenced shortly after August 18, 1914. The first dispute was referred to the Secretary on March 15, 1915.*Results.*—To June 30, 1916, 1,107 disputes, involving 71,491 bales of cotton, have been referred to the Secretary, upon which findings have been issued.*Assignment.*—R. L. Francis, Hal Brown, R. A. Freret, A. M. Agelasto.*Proposed expenditures, 1916-17.*—\$38,440.

[Service.]

Preparation and Distribution of the Official Cotton Standards of the United States:*Object.*—To prepare and distribute the official cotton standards of the United States for grades of white cotton, promulgated by the Secretary of Agriculture on December 15, 1914, under section 9 of the United States cotton-futures act; and the official standards for colored cotton, promulgated by the Secretary of Agriculture on January 28, 1916, under the same section of the same act; and to inspect and condemn these standards when necessary and replace them upon request. (Field and laboratory investigations and demonstrations of standards are carried on under another project.)*Procedure.*—Bales of cotton of the various grades representing the characteristic qualities of the cotton of each State are purchased throughout the cotton belt and used for the preparation of copies of the official standards. Copies of the standards are placed in boxes constructed for the purpose, certified under the

Preparation and Distribution of the Official Cotton Standards of the United States—Continued.

seal of the Department of Agriculture, and are accompanied by photographs made of the contents of each box at the time of certification.

The standards for white cotton are prepared in sets of 9 boxes, each box representing a grade and containing 12 samples or types showing the degree of variation permissible within the grade, and are sold at \$20 a set. The standards for colored cotton are prepared in sets of 11 boxes, each box representing a grade and containing 12 samples showing the degree of variation permissible within the grade. The standards for colored cotton are sold at \$25 a set. Fractional or broken sets of standards are supplied upon request. Purchasers of official standards hold them subject to inspection by representatives of the Department of Agriculture, and if for any reason they are found upon inspection to have deteriorated since their preparation, or to misrepresent the official cotton standards in any way, the certificate of grade may be canceled or removed. Examination of any set or box of standards delivered at Washington by the purchasers will be made free of charge, and any sample or type which may be out of line with the official cotton standards will be replaced at a nominal charge, the photograph of the box being renewed without cost.

Location.—Washington, D. C.

Date begun.—1914.

Results.—(1) During 1916: The following standards have been established and were promulgated on January 28, 1916: Yellow-tinged cotton of the grades of good middling, strict middling, middling, strict low middling, and low middling; yellow-stained cotton of the grades of good middling, strict middling, and middling; and blue-stained cotton of the grades of good middling, strict middling, and middling.

There were prepared and distributed in the United States in response to the demand of purchasers 245 full and 77 fractional sets of the white standards promulgated December 15, 1914, and 31 sets of the colored standards. In addition to these, 3 full sets and 1 fractional set of the white standards were sent to Canada and Japan. Since the promulgation of the white standards on December 15, 1914, a total of 633 full and 78 fractional sets of the white standards have been shipped, and of this number 19 full sets and 1 fractional set have been sold to foreign countries; 31 sets of the colored standards have been sold in the United States.

(2) Prior to 1916: The following standards for grades of white cotton were established and promulgated on December 15, 1914: Middling fair, strict good middling, good middling, strict middling, middling, strict low middling, low middling, strict good ordinary, and good ordinary. Prior to the fiscal year 1916, 369 sets of these white standards were distributed throughout the United States and 16 sets had been sent to foreign countries, including Canada, England, India, China, Japan, Holland, Germany, France, and Russia.

Assignment.—Fred Taylor, D. E. Earle, B. M. Botto, R. L. Kause, M. L. Rice, George P. Taylor.

Proposed expenditures, 1916-17.—\$51,440.

[Research.]

Investigations of Future and Spot Markets for Cotton:

Object.—To investigate future markets for cotton to ascertain how accurately their future quotations reflect spot values, and to secure general information as to conditions within the future exchanges; to investigate spot markets to determine their fitness for designation as bona fide spot markets; to secure daily reliable quotations for cotton from each of the designated spot markets; and to inspect the designated bona fide spot markets from time to time.

Procedure.—Investigations are made of transactions in future markets to ascertain whether the provisions of the act are being carried out, and of various spot markets to determine whether they are qualified for designation as bona fide spot markets, i. e., whether the exchanges in these markets will meet certain conditions necessary for the designation of same as bona fide spot markets. Quotations received from these bona fide spot markets are checked to determine whether they are correct and whether they continue to meet the requirements of a bona fide spot market.

Cooperation.—Cotton exchanges in the designated spot markets, the future exchanges at New York and New Orleans, the New England Cotton Buyers' Association, Boston, Mass., the Arkwright Club, Boston, Mass., and numerous cotton firms throughout the United States.

Investigations of Future and Spot Markets for Cotton—Continued.*Location.*—Washington, D. C.*Date begun.*—1914.

Results.—At present the following cities are designated as bona fide spot markets for cotton under the cotton-futures act: Augusta, Ga., Dallas, Tex., Houston, Tex., Little Rock, Ark., Memphis, Tenn., Montgomery, Ala., Norfolk, Va., Savannah, Ga., Boston, Mass., New Orleans, La., Charleston, S. C., Mobile, Ala., Galveston, Tex., and Fort Worth, Tex. Quotations are received at this office and by the future exchanges at New York and New Orleans from the first 11 of the cities named. The average of these quotations constitutes commercial differences for use in the settlement of future contracts made on the New York Cotton Exchange.

Assignment.—William R. Meadows, G. R. Argo, R. L. Crittenden, H. E. Tucker.*Proposed expenditures, 1916-17.*—\$22,940.

Total, Enforcement of the United States Cotton-Futures Act, \$163,350, including \$16,600 statutory (regulation, \$55,900; service, \$72,200; research, \$35,250). This total includes \$26,000 of an estimated unexpended balance of \$66,000 from continuing appropriation of \$150,000 made available under the cotton-futures act of August 18, 1914.

[Regulation and Research.]

ADMINISTRATION OF THE UNITED STATES WAREHOUSE ACT.**Administration of the United States Warehouse Act:**

Object.—To inspect and classify warehouses applying for licenses under the United States warehouse act; to license warehouses that are found to be suitable for the proper storage of cotton, grains, flaxseed, wool, and tobacco; to license weighers and graders for the purpose of weighing and grading agricultural products to be stored in warehouses licensed under this act; to license any person not a warehouseman to accept custody of cotton, grains, flaxseed, wool, and tobacco, and to store same in a warehouse owned or operated by any State; to prescribe the duties of warehousemen licensed by the Secretary of Agriculture, to make rules and regulations for carrying out the provisions of the United States warehouse act, and to prescribe the conditions of the bond required of licensed warehousemen; to investigate the storage, warehousing, classifying, according to grade or otherwise, weighing, and certification of cotton, grains, flaxseed, wool, and tobacco; and to make such other investigations as may be necessary for carrying out the provisions of the United States warehouse act.

Procedure.—Study will be made of the practices of warehousemen in order to make rules and regulations for carrying out the provisions of the warehouse act. Forms for applications and inspections will be drafted, and when warehousemen or weighers and graders apply for licenses under the act such inspections and examinations as may seem necessary will be made to determine whether the warehouses are suitable for the proper storage of agricultural products and to determine whether the applicants for licenses as weighers and graders are capable of performing these duties. Such inspections as may seem necessary will be made in order to classify warehouses in accordance with the provisions of the act. Where no legal standards of classification have been provided for agricultural products to be stored in licensed warehouses, a study of the standards and grades now in use will be made in order to determine what standard shall be designated for use in grading agricultural products stored in a licensed warehouse, and, in case none of the standards at present in use are found satisfactory, standards for the classification of such products will be fixed and promulgated.

Cooperation.—Office of the Solicitor and other branches of the department; State experiment stations, colleges of agriculture, private individuals, commercial companies, insurance and bonding companies, underwriters' associations, and State officials in charge of State warehousing and marketing departments.

Location.—Washington, D. C.; all sections where agricultural products as defined in the act are grown and stored and places outside of the producing sections where such products are concentrated and held in storage.

Date begun.—August, 1916.

Assignment.—R. L. Nixon, Roy L. Newton, and such additional men as may be necessary, with experience in warehousing cotton, wool, grain, tobacco, and flaxseed.

Proposed expenditures, 1916-17.—\$50,000.

ENFORCEMENT OF THE UNITED STATES GRAIN-STANDARDS ACT.

Administration:

Object.—To supervise and direct the investigational and regulatory activities involved in the enforcement of the United States grain-standards act and the rules and regulations of the Secretary of Agriculture thereunder, and to perform such executive and clerical duties as may be necessary in connection therewith.

Cooperation.—The Office of the Solicitor in matters involving points of a legal nature and questions of general policy; other offices and bureaus of the department, and State and commercial grain interests of the United States. Certain phases of the work relating to the enforcement of the United States warehouse act will be carried on in cooperation with work conducted under this appropriation.

Location.—Headquarters, Washington, D. C. As the administration of the act proceeds it is likely that permanent branch offices will be established in the following great grain markets: New York, Philadelphia, Baltimore, Chicago, Buffalo, Cincinnati, Milwaukee, St. Louis, Kansas City, Minneapolis, Duluth, Galveston, New Orleans, Omaha, Portland, San Francisco, and Seattle.

Date begun.—August, 1916.

Assignment.—Charles J. Brand and Wm. A. Taylor. Advisory committee: J. W. T. Duvel, chairman, George Livingston, and chief supervisor (to be appointed).

Proposed expenditures, 1916-17.—\$30,000 (research, \$10,500; regulation, \$19,500).

[Research.]

Investigation and Determination of Grain Standards:

Object.—To investigate such phases of harvesting, handling, transportation, storage, and grading of grain as contribute information fundamental and necessary for establishing, fixing, and perfecting standards for corn, wheat, rye, oats, barley, grain sorghums, flaxseed, and such other grains as the usages of the trade may warrant and justify; to investigate the relations of grades and standards to the feeding and manufacturing value of sound and unsound grain; to investigate the influence on grade of biophysical, biochemical, and physiological changes which take place in grain during harvesting, transportation, and storage; to develop and perfect laboratory methods for determining the condition and quality of grain and to develop and perfect special apparatus for use in grain grading.

Procedure.—The information now available in the Office of Grain-Standardization Investigations of the Bureau of Plant Industry will be compiled and brought into immediate service for use in establishing grades. This information will be supplemented by field studies of such phases of harvesting, handling, transportation, and storage of grain as contribute information useful in perfecting old and establishing new standards from time to time for promulgation by the Secretary of Agriculture.

Cooperation.—This investigation will be conducted in cooperation with the projects, "Grain Handling and Transportation Investigations," Enforcement of the United States Grain-Standards Act; "Grain, Hay, and Seeds Marketing Investigations," Office of Markets and Rural Organization; various bureaus and offices of the department; and producers, shippers, dealers, and other agencies handling and inspecting grain, including the common carriers.

Location.—Washington, D. C., and points in the field. Research laboratories will be maintained at the important grain marketing centers.

Assignment.—J. W. T. Duvel.

Proposed expenditures, 1916-17.—\$100,900 (\$73,770 from the appropriation for grain standardization, and \$16,980 statutory salaries, Bureau of Plant Industry, and \$10,150 from the appropriation for enforcement of the United States grain-standards act).

Grain Handling and Transportation Investigations:

Object.—To investigate general and specific commercial problems connected with the handling, transportation, and storage of grain, including methods employed on the farm, at the country elevator, and at distributing and consuming centers; the effect of shrinkage, drying, bleaching, mixing, dockage, cleaning, and handling on commercial value and market practice; the relation of transportation facilities to economic and efficient marketing and distribution of grain in domestic and foreign commerce; the construction and equipment of elevators and warehouses in their relation to efficient and economic handling, transportation, and storage of grain; and the investigation of such other related subjects as may furnish information useful to the various agencies engaged in the handling, transportation, storage, and merchandising of grain.

Procedure.—The information now available in the Office of Grain-Standardization Investigations of the Bureau of Plant Industry and the Office of Markets and Rural Organization will be used as a foundation for continued investigations in the handling and transportation of grain. Field studies will be made of the general and specific problems involved in handling and transportation of grain, special attention being given to methods adapted to certain sections and conditions, including the handling, transportation, and storage of special grain crops. The results of such investigations will be compiled and published in the most convenient form for the use and information of those interested in the handling and transportation of grain.

Cooperation.—Grain Standardization Investigations, Bureau of Plant Industry; Grain Seed and Hay Marketing and Transportation and Storage Investigations, Office of Markets and Rural Organization; and producers, shippers, and handlers of grain and other agencies interested in the problems under consideration, including the common carriers.

Date begun.—August, 1916.

Location.—Washington, D. C., and points in the field.

Assignment.—J. W. T. Duvel and George Livingston, jointly in charge.

Proposed expenditures, 1916-17.—\$35,000 (\$20,000 from the appropriation for the enforcement of the United States grain-standards act and \$15,000 from the appropriation for grain standardization, Bureau of Plant Industry).

[Regulation.]**Licensing of Inspectors:**

Object.—To determine the competence of persons applying for license under the United States grain-standards act and to issue to qualified persons licenses for inspecting and grading grain and certifying the grade thereof and to suspend or revoke licenses in accordance with the provisions of the United States grain-standards act.

Procedure.—Applicants will be examined by methods to be determined, in cooperation with the Civil Service Commission, and qualified persons will be licensed to inspect and grade grain for shipment or delivery for shipment in interstate or foreign commerce and to certificate the grade thereof. Hearings will be held, and licenses of inspectors will be suspended or revoked when necessary upon charges of incompetency, for knowingly or carelessly grading grain improperly or by other than the United States standards, for the issuance of false certificates, for the acceptance of money or other considerations, neglect or improper performance of duty, or for violations of the act or the rules and regulations made thereunder.

Cooperation.—Same as "Administration."

Location.—See "Administration."

Assignment.—Charles J. Brand.

Proposed expenditures, 1916-17.—\$15,000.

Supervision of Inspection of Grain:

Object.—To supervise the inspection of grain in order to secure the accurate application of the official grain standards of the United States; to prepare and enforce rules and regulations covering inspection of grain not inspected by a licensed inspector at the point of origin but to be inspected in transit or at destination and with reference to grain sold or offered for sale by grade without inspection; to cause examinations to be made of any grain which has been shipped or delivered for shipment into interstate or foreign commerce when sold or offered for sale by grade or which has been graded by a licensed inspector, for the purpose of determining whether it conforms to the standard

Supervision of Inspection of Grain—Continued.

of the grade specified in the certificate; to hold hearings and publish findings whenever it appears either that the grain has been incorrectly certified or that it has been sold, offered for sale, or consigned for sale under any name, description, or designation which is false or misleading; to make all investigations of fact which may be a necessary precedent to the suspension or revocation of licenses, and to make recommendations with respect thereto; and to supervise the keeping of all records of grain graded and inspected by licensees under the act, the collection of reports, and the compilation for publication of a summary of facts as required by law.

Procedure.—Such general rules and regulations as may be necessary for carrying out the objects mentioned and special rules and regulations in accordance with the second and third provisos of section 4 will be prepared. The enforcement of the rules and regulations affecting the activities of licensed inspectors will constitute the chief activity of the project. Supervisors will make examinations from time to time of grain which has been certified to conform to the official standards or which has been shipped or delivered for shipment into interstate or foreign commerce. If in their opinion it does not conform to grade, hearings will be held and findings published. Adequate forms of record for reporting to the Secretary of Agriculture the place and date of inspection, name of elevator or warehouse, and the kind, quantity, and grade of grain will be prepared immediately. Summaries of the information obtained from these records will be prepared for publication on the first Tuesday in January and the first Tuesday in July of each year, as provided in the act.

Cooperation.—Same as "Administration."

Location.—Washington, D. C., and at all of the great terminal grain markets.

Assignment.—Charles J. Brand.

Proposed expenditures, 1916-17.—\$154,850.

Determination of Disputes and Appeals:

Object.—To hear and determine disputes and appeals which may be referred to the Secretary of Agriculture regarding grade and quality of grain, and to prepare and sign findings in each case.

Procedure.—Rules and regulations will be prepared defining the procedure to be followed in referring disputes and appeals to the Secretary of Agriculture. The personnel will be selected and stationed in such a manner as to allow the creation therefrom of boards of appeal for the purpose of quickly determining disputes and appeals.

Cooperation.—Same as "Administration."

Location.—Washington, D. C., and important grain marketing centers.

Assignment.—Charles J. Brand.

Proposed expenditures, 1916-17.—\$20,000.

Total, Enforcement of the United States Grain-Standards Act, \$355,750 (research, \$146,400; regulation, \$209,350).

INSECTICIDE AND FUNGICIDE BOARD.

ENFORCEMENT OF THE INSECTICIDE ACT.

Administration:

Object.—To act for the board in all matters pertaining to the enforcement of the insecticide act and incidental business affairs.

Procedure.—Samples of insecticides and fungicides are collected by inspectors operating throughout the United States, and samples from consignments offered for import at the various ports of entry are taken; distribution is made of such samples for analysis and test, and reports thereon are assembled and all necessary action taken to carry out the recommendations of the board in respect to the disposition of cases and administrative matters, including the arranging for hearings, collecting evidence, correspondence, preparing cases for reference to the Solicitor, maintaining records and files, attending to fiscal matters, purchasing and accounting for property, and all other business details.

Cooperation.—Bureaus of Animal Industry, Plant Industry, Chemistry, and Entomology, and Office of the Solicitor; and Treasury, Commerce, and State Departments.

Location.—Washington, D. C.

Date begun.—1910.

Results.—General compliance with the law is being obtained, resulting in great improvement in labeling and better and more standardized grades of the products appearing on the market.

Assignment.—J. K. Haywood, chairman of board; J. G. Shibley, executive officer.

Proposed expenditures, 1916-17.—\$41,361 (regulation, \$40,761; research, \$600), including reserve of \$11,000 for the trial of cases.

[Regulation.]

Routine Chemical, Microscopic, and Bacteriological Examination of Insecticides and Fungicides (Including Disinfectants) Other than Those Used on Horses, Cattle, Sheep, Swine, or Goats:

Object.—To control the traffic in domestic and foreign insecticides and fungicides of the type mentioned.

Procedure.—Samples of these insecticides and fungicides are collected in the open market and examined to determine whether or not they are adulterated or misbranded under the provisions of the insecticide act.

Cooperation.—Same as project "Administration."

Location.—Washington, D. C.

Date begun.—1910.

Results.—Same as project "Administration." A special campaign has been made against misbranded and adulterated disinfectants, with the result that a great improvement has been begun in this direction.

Assignment.—J. K. Haywood, chairman of board.

Proposed expenditures, 1916-17.—\$31,406.

Routine Testing of Efficacy of Fungicides and Action on Foliage of Insecticides and Fungicides:

Object.—To control interstate traffic in domestic and foreign fungicides and insecticides.

Procedure.—Samples of fungicides and insecticides collected in the open market are tested to determine whether they are adulterated or misbranded under the provisions of the insecticide act.

Cooperation.—Same as project "Administration."

Location.—Washington, D. C., Arlington Farm, Va., and leased orchards and truck patches.

Date begun.—1910.

Results.—Same as project "Administration."

Assignment.—M. B. Waite, member of board.

Proposed expenditures, 1916-17.—\$7,562.

Routine Testing of Efficacy of Insecticides and Their Action on Follage:

Object.—To control interstate traffic in domestic and foreign insecticides.

Procedure.—Samples of insecticides collected in the open market are tested to determine whether or not they are adulterated or misbranded under the provisions of the insecticide act.

Cooperation.—Same as project "Administration."

Location.—Washington, D. C., and Vienna, Va.

Date begun.—1910.

Results.—Same as project "Administration."

Assignment.—A. L. Quaintance, member of board.

Proposed expenditures, 1916-17.—\$9,138.

Routine Chemical and Bacteriological Examination of Insecticides and Fungicides Used Primarily on Horses, Cattle, Sheep, Swine, or Goats, and Efficacy Tests of Same:

Object.—To control traffic in the domestic and foreign insecticides and fungicides of the type mentioned.

Procedure.—Samples of these insecticides and fungicides are collected in the open market and examined to determine whether or not they are adulterated or misbranded under the provisions of the insecticide act.

Cooperation.—Same as project "Administration."

Location.—Washington, D. C.

Date begun.—1910.

Results.—Same as project "Administration."

Assignment.—James A. Emery, member of board.

Proposed expenditures, 1916-17.—\$8,633.

[Research.]

Chemical, Microscopic, and Bacteriological Investigations of Insecticides and Fungicides (Including Disinfectants) Other than Those Used on Horses, Cattle, Sheep, Swine, or Goats:

Object.—To obtain basic information relative to these insecticides and fungicides and of materials used in their preparation, which is necessary in the enforcement of the insecticide act, improve methods of examining insecticides and fungicides, establish standards for insecticides and fungicides, and aid manufacturers in methods of manufacture.

Procedure.—As new questions arise relative to methods of analysis, standards for insecticides and fungicides, the chemistry of new insecticides and fungicides, and methods of manufacturing insecticides and fungicides, they are made the subject of investigative study.

Cooperation.—Bureau of Chemistry.

Location.—Washington, D. C.

Date begun.—1910.

Results.—(1) During 1916: Analytical work necessary to establish standards for insect powder nearly completed and a method developed for determining the amount of stems in insect powder; an article completed and offered for publication on "The Preparation and Properties of Lead Chlorarsenate"; studies made of the preparation and properties of various other lead arsenates and various calcium arsenates; and an investigation completed and published on "The Reduction of As^v to As^{iii} by Cuprous Chloride and the Determination of Arsenic by Distillation as Arsenic Trichloride."

(2) Prior to 1916: New methods of examining many insecticidal and fungicidal materials evolved; standards for certain insecticides and fungicides tentatively adopted on the basis of this work; the chemical properties of insecticides and fungicides investigated, and suggestions furnished to manufacturers relative to methods of manufacturing insecticides and fungicides; a paper on "The Electrolytic Separation of Zinc, Copper, and Iron from Arsenic" published.

Assignment.—J. K. Haywood, chairman of board; C. C. McDonnell.

Proposed expenditures, 1916-17.—\$4,000.

Investigations of the Efficacy of Fungicides and Action of Fungicides and Insecticides on Vegetation:

Object.—To obtain basic information necessary in the enforcement of the insecticide act relative to the action of fungicidal materials on fungi, improve methods of testing fungicides, and secure data relative to the action of fungicides and insecticides and insecticidal and fungicidal materials on vegetation.

Investigations of the Efficacy of Fungicides and Action of Fungicides and Insecticides on Vegetation—Continued.

Procedure.—As new questions arise relative to the activity or nonactivity of fungicides and fungicidal materials and the action of fungicides, insecticides, and insecticidal and fungicidal materials on vegetation, these are made the subject of investigative study.

Cooperation.—Bureaus of Plant Industry, Entomology, and Chemistry.

Location.—Washington, D. C., Arlington Farm, Va., and leased orchards and truck patches.

Date begun.—1910.

Results.—The activity or nonactivity against fungi of a number of substances determined; action of a number of groups of insecticides and fungicides on vegetation also determined and general conclusions drawn relative thereto; results used in correspondence and in the enforcement of the insecticide act.

Assignment.—M. B. Waite, member of board; Errett Wallace.

Proposed expenditures, 1916-17.—\$800.

Investigations of the Efficacy of Insecticides and Action of Same on Vegetation:

Object.—To obtain information relative to the action of insecticides and insecticidal materials on insects, as necessary in the enforcement of the insecticide act; to improve methods of testing insecticides; and to secure data relative to the action of insecticides and insecticidal materials on vegetation.

Procedure.—As new questions arise relative to the activity or nonactivity of insecticides and insecticidal materials and the action of same on vegetation, these are made the subject of investigative study.

Cooperation.—Bureaus of Entomology, Plant Industry, and Chemistry.

Location.—Washington, D. C., and Vienna, Va.

Date begun.—1910.

Results.—The activity or nonactivity against various insects of a large number of substances determined; action of a number of insecticidal substances on vegetation also determined and general conclusions drawn relative thereto; results used in the enforcement of the insecticide act and in correspondence.

Assignment.—A. L. Quaintance, member of board; E. W. Scott.

Proposed expenditures, 1916-17.—\$1,500.

Chemical, Bacteriological, and Toxicological Investigations of Insecticides and Fungicides Used Primarily on Horses, Cattle, Sheep, Swine, or Goats, and Efficacy Tests of Same:

Object.—To obtain basic information relative to these insecticides and fungicides and of materials used in their preparation, which is necessary in the enforcement of the insecticide act; to improve methods of examining and testing such insecticides and fungicides; to secure data relative to the activity or nonactivity of substances used in such insecticides and fungicides; and to investigate the toxic action of such insecticides, fungicides, and materials which are used in their preparation.

Procedure.—As new questions arise relative to methods of analysis, the activity or nonactivity of certain substances used in insecticides and fungicides, the efficacy of certain insecticides and fungicides, and the toxic action of certain insecticides and fungicides and materials used in same, these are made the subject of investigative study.

Cooperation.—Bureau of Animal Industry.

Location.—Washington, D. C.

Results.—New methods of examining certain insecticides and fungicides have been evolved, the activity or nonactivity against insects and fungi of many substances determined, and the toxic properties of a number of substances ascertained; results used in the enforcement of the insecticide act and in correspondence.

Assignment.—J. A. Emery, member of board.

Proposed expenditures, 1916-17.—\$600.

Total, Enforcement of the Insecticide Act, \$105,000, including \$24,590 statutory (regulation, \$97,500; research, \$7,500).

FEDERAL HORTICULTURAL BOARD.

ENFORCEMENT OF THE PLANT-QUARANTINE ACT.

ADMINISTRATION.

Administration:

Object.—Supervision of the board's activities and the performance of such duties as are common to the board as a whole, the cost of which can not be readily prorated against the various projects involved, such as accounting and editorial work, purchasing, distributing and accounting for property and supplies, arranging for hearings and conducting hearings, collecting evidence, preparing cases for reference to the Solicitor, correspondence, maintaining records and files, and all other business details necessary for carrying out the recommendations of the board.

Cooperation.—Bureaus of Entomology, Plant Industry, and Chemistry, and Forest Service; Offices of the Solicitor, Markets and Rural Organization, and Information; and Treasury, State, and Post Office Departments.

Location.—Washington, D. C.

Date begun.—1912.

Results.—General compliance with the law and with the quarantine and other restrictive orders issued thereunder is being obtained.

Assignment.—C. L. Marlatt, chairman; R. C. Althouse, secretary.

Proposed expenditures, 1916-17.—\$12,000, including \$8,860 statutory (regulation, \$11,000; research, \$1,000).

[Regulation.]

CONTROL OF ENTRY OF PLANTS AND PLANT PRODUCTS UNDER REGULATION.

Nursery Stock:

Object.—To guard against the introduction of injurious plant diseases and insect pests.

Procedure.—Issuance of permits; providing for foreign inspection and certification of nursery stock and for reinspection of such stock either at port of entry or at place of destination; securing proper reports from importers and customs officials of arrival and proposed distribution, and transmitting such reports to State inspectors; keeping records of importations, and taking steps to maintain full compliance with the regulations on the part of inspectors in export countries as to proper certification and marking, and on the part of importers as to notification, examination, or disinfection at port of entry or at destination.

Cooperation.—State inspectors, customs officials, American consuls and postmasters, and inspectors in foreign countries.

Location.—Washington, D. C., and ports of entry concerned.

Date begun.—1912.

Results.—General compliance with regulations being secured; marked improvement in condition of nursery stock as to freedom from pests.

Assignment.—C. L. Marlatt, E. R. Sasser, R. Kent Beattie.

Proposed expenditures, 1916-17.—\$12,000.

Potatoes:

Object.—To guard against the introduction of injurious potato diseases and insect pests.

Procedure.—Issuance of permits; providing for foreign inspection and certification and for reinspection at port of entry; securing proper reports of arrival from importers and customs officials; keeping records of importations; and taking steps to maintain full compliance with the regulations on the part of inspectors in export countries as to proper certification and marking, and on the part of importers as to notification and inspection at port of entry.

Cooperation.—State inspectors, customs officials, American consuls, and inspectors in foreign countries.

Location.—Washington, D. C., and ports of entry concerned.

Potatoes—Continued.

Date begun.—1913.

Results.—General compliance with regulations being secured; marked improvement in condition as to freedom from disease of potatoes offered for entry.

Assignment.—C. L. Marlatt, R. Kent Beattie, H. B. Shaw.

Proposed expenditures, 1916-17.—\$8,000.

Avocados:

Object.—To guard against the introduction of the avocado weevil.

Procedure.—Issuance of permits; securing proper reports of arrival from the importers and customs officials; providing for inspection of avocados at port of entry; keeping records of importations; and taking steps to maintain full compliance with the regulations on the part of importers as to notification and inspection at port of entry.

Cooperation.—Customs officials and American consuls.

Location.—Washington, D. C., and New York City.

Date begun.—1914.

Results.—General compliance with regulations being secured.

Assignment.—C. L. Marlatt, H. B. Shaw.

Proposed expenditures, 1916-17.—\$100.

Cotton:

Object.—To guard against the introduction of the pink bollworm and other cotton pests.

Procedure.—Issuance of permits to import and licenses to purchase, use, and store foreign cotton; securing proper reports of arrival from importers and customs officials; providing for the inspection, disinfection, and certification of cotton at port of entry; and keeping records of importations, disinfection, and distribution of cotton. Since March 10, 1916, all foreign cotton has been disinfected under the supervision of an inspector of the Department of Agriculture prior to entry, and the ports of entry are limited to northern cities. As an additional precaution, all users of imported cotton are required to safeguard their premises by thorough screening or fastening of windows, doors, and other openings in the warehouses or storerooms and opening and cleaning rooms, and to destroy the picker waste from foreign cottons by burning.

Cooperation.—Customs officials and American consuls and postmasters.

Location.—Washington, D. C., and ports of entry concerned.

Date begun.—1915.

Results.—General compliance with regulations being secured. A method of disinfecting cotton with hydrocyanic-acid gas has been devised by Mr. E. R. Sasser, chief inspector of the board, whereby it is possible to penetrate to the innermost parts of a bale and destroy all contained insect pests. As the result of this method, there are now in active operation adequate fumigation plants at various ports of entry.

Assignment.—C. L. Marlatt, Jos. H. Batt, R. I. Smith.

Proposed expenditures, 1916-17.—\$29,000.

Total, Control of Entry of Plants and Plant Products under Regulation,
\$49,100, including \$4,780 statutory.

[Regulation.]

FOREIGN PLANT QUARANTINES.**Foreign Plant Quarantines:**

Object.—To prevent, under existing quarantines, the entry of plant material affected with white-pine blister rust, potato wart, Mexican fruit fly, avocado weevil, the pink bollworm of cotton, European pine-shoot moth, citrus canker and other citrus diseases, *Sclerospora maydis* and other diseases of Indian corn, and insect enemies and plant diseases of sugar cane; and to provide for like control by quarantine of any new danger that may arise. Nine such quarantines, covering the subjects enumerated above, are now in force.

Procedure.—The quarantines are promulgated after due notification and hearing. These quarantines prohibit the entry of the articles covered, and their enforcement is effected largely by cooperation with the Treasury and Post Office Departments, which greatly reduces the cost of control. Foreign notification is effected through the State Department. Cooperation in the checking of violations is also obtained through the official inspectors of our several States acting in the capacity of collaborators of the board.

Foreign Plant Quarantines—Continued.

Cooperation.—Customs officials and postmasters.

Location.—Washington, D. C., and ports of entry concerned.

Date begun.—1912.

Results.—Practical prohibition effected of articles covered; exceptional instances of entry followed up and goods destroyed.

Assignment.—C. L. Marlatt.

Proposed expenditures, 1916-17.—\$3,000.

[Regulation.]

DOMESTIC PLANT QUARANTINES.**Domestic Plant Quarantines:**

Object.—To prevent, under existing quarantines, further distribution within the United States of the Mediterranean fruit fly and melon fly, the gipsy moth and brown-tail moth, date-palm scale insects, the pink bollworm of cotton, and insect enemies and plant diseases of sugar cane; and by future quarantine to control any new pest that may appear. Six such quarantines, covering the subjects enumerated above, are now in force.

Procedure.—Promulgation of quarantine after due notification and hearing; provision for enforcement of the regulations governing inspection, disinfection, and certification.

Cooperation.—State commissioners of agriculture and horticulture, State inspectors, postmasters, and particularly the Bureau of Entomology of this department.

Location.—Washington, D. C., with branch stations in districts particularly concerned by quarantines, including the New England States, Webb County, Tex., Yuma, Maricopa, and Pinal Counties, Ariz., Riverside and Imperial Counties, Cal., and Porto Rico and Hawaii.

Date begun.—1912.

Results.—These quarantines are now in full operation with adequate inspection service, and the further spread of the pests enumerated under "Object" is either prevented or greatly retarded.

Assignment.—C. L. Marlatt.

Proposed expenditures, 1916-17.—\$5,000. (The cost of the enforcement of the gipsy moth and brown-tail moth quarantine and the Mediterranean fruit fly and melon fly quarantine is met from specific appropriations made to the Bureau of Entomology of this department.)

(Inspection and Certification of Potatoes for Interstate Shipment from Areas Quarantined for Powdery Scab: Project discontinued September 1, 1915. Investigations and surveys showed that the powdery scab of potato is largely limited by soil conditions and that the spread of the disease to the Southern and Central States is improbable. It was felt, therefore, that there was no justification for continuing the quarantine on account of this disease.)

[Research.]

PLANT QUARANTINE INVESTIGATIONS.**Plant Quarantine Investigations:**

Object.—Investigation of insect and plant-disease conditions as a basis for needed quarantine action.

Procedure.—When it is brought to the attention of the Federal Horticultural Board that a dangerous plant pest liable to be imported into the United States occurs in some foreign country, or has already obtained a limited foothold in the United States, if the additional information needed before intelligent quarantine action can be taken can not be promptly furnished by the bureau of the department concerned, qualified experts are detailed to make the necessary studies and investigations.

Cooperation.—Various bureaus in the Department of Agriculture, other scientific bureaus of the Government, the related officials of the several States, foreign officials, and the experts and associations or individuals concerned.

Location.—These investigations are necessarily of a temporary nature and to meet the immediate need. A list of such research or investigative work hitherto undertaken is given in the paragraph entitled "Results."

Plant Quarantine Investigations—Continued.

Results.—(1) During 1916: Life-history studies of the pink bollworm of cotton were carried on in Hawaii as a basis for the regulation of the movement of Hawaiian cotton; and surveys were made for the powdery scab of potato, which had an important bearing on the lifting of the domestic potato quarantines.

(2) Prior to 1916: Studies of fruit-fly conditions in Mediterranean countries, Bermuda, and Mexico were made, which have furnished the basis for quarantine control; the distribution and importance of powdery scab and other potato diseases in Europe, the Dominion of Canada, and in relation to domestic quarantines in Maine and in Clinton and Franklin Counties, N. Y., were determined, and surveys made to determine possible distributions in other States.

Assignment.—C. L. Marlatt.

Proposed expenditures, 1916-17.—\$5,900.

Total, Enforcement of the Plant-Quarantine Act, \$75,000, including \$13,640 statutory (regulation, \$68,100; research, \$6,900).

MISCELLANEOUS.

LIVE-STOCK PRODUCTION IN CANE-SUGAR AND COTTON DISTRICTS.

[Research.]

Experiments in Live-Stock Production in Cane-Sugar and Cotton Districts:

Object.—To determine the best methods of producing live stock on a commercial scale in the cane-sugar and cotton districts.

Procedure.—For the purpose of conducting experimental work to determine the cost of producing different kinds of live stock, a farm between New Iberia and Jeanerette, La., consisting of 500 acres, has been divided into four subdivisions or small farms, one devoted to the production and finishing of beef cattle, one to the production of hogs, another to dairy cattle, and a fourth to the production of mules and to the feeding of the work animals on the farm. These farms are to be kept entirely distinct in every respect. It is planned to utilize to the greatest possible extent pasturage, supplemented with crops to be grazed off by the animals, using the minimum amount of purchased feed or feed from the barns.

It is proposed to establish crop rotations and to determine what methods of handling the animals will be most economical, dealing with animals in rather large numbers. All the knowledge available about the production of crops and the feeding of animals will be applied on these farms for the purpose of making a definite determination of the commercial possibilities of live-stock production in that region.

Cooperation.—Work organized and undertaken cooperatively by the Department of Agriculture and the Louisiana Experiment Station.

Location.—Jeanerette, La.

Date begun.—1914.

Results.—The farm has been laid off in pastures and plats for various forage crops. The pastures have been seeded to grasses and clovers, and crops in the various rotations are being planted in their proper season. Fences have been erected. An office building, pump house, tool shed, horse and mule barn, jack shed, hog feed house, 13 hog cots, 2 beef-cattle barns, 4 concrete silos, 4 wooden silos, 6 negro cabins, and 3 dwelling houses for the superintendent and his assistants have been built. The work stock for the place includes mares and mules. The mares are used for breeding purposes. In 1914-15 two carloads of steers were fed on cane tops and whole cane, and the animals sold. In 1915-16, 100 head of cattle were fed on silage made from cane tops; corn; sorghum; corn sorghum and legumes; corn and soy beans; and corn and sorghum.

A breeding herd of beef cattle consisting partly of native stock and partly of Herefords has been purchased. A dairy barn is being erected, and a dairy grade herd will be started this fall.

Assignment.—These investigations are under the supervision of the following committee appointed by the Secretary of Agriculture: W. A. Taylor, chief of the Bureau of Plant Industry; B. H. Rawl, chief of the Dairy Division, Bureau of Animal Industry, and W. R. Dodson, director of the Louisiana Experiment Station, Baton Rouge, La. C. E. Mauldin, of the Bureau of Animal Industry, has immediate charge of all the work of the station but is directly responsible to the committee.

Proposed expenditures, 1916-17.—\$40,000.

[Extension.]

Live-Stock Extension Work in Louisiana:

Object.—To disseminate information relative to the best methods to be used in producing live stock in the cane-sugar and cotton districts of Louisiana. The lines to be covered will include beef cattle, hogs, horses and mules, poultry, dairying, and forage crops.

Procedure.—The best information now available regarding live-stock production will be disseminated among the farmers, through demonstrations and in other ways, by live-stock specialists. Later, when the results of the experiments conducted on the live-stock farm at New Iberia become available, this information will be carried to the farmers in a similar manner.

Live-Stock Extension Work in Louisiana—Continued.

Cooperation.—This work is organized and directed cooperatively by the Department of Agriculture and the extension division of the Louisiana State University. On the part of the department, the work is carried on by the Bureaus of Animal Industry and Plant Industry, in cooperation with the States Relations Service.

Location.—Throughout the cane-sugar and cotton districts of Louisiana.

Date begun.—1914.

Results.—Last year 34 poultry, 31 hog, and 22 beef-cattle demonstrations were organized in connection with county agents. The dairy agent assisted in the building of 36 silos (13 concrete and 23 stave), 8 new dairy barns, and 6 dairy houses. As fast as the demonstrations produce visible results they are used as centers around which the residents of the community are brought together at informal meetings to observe what is being done. A cow-testing association was organized. At the State fair demonstrations of milk testing, butter making, etc., were given. The forage-crop agent has introduced proper cropping systems on the farms where the various cattle, hog, and poultry demonstrations are made. The live-stock extension force assist at public meetings, locating animals for breeding purposes, etc.

Assignment.—G. E. Nesom, leader of live-stock extension work, under the direction of W. R. Dodson.

Proposed expenditures, 1916-17.—\$20,000.

Total, Live-Stock Production in Cane-Sugar and Cotton Districts, \$60,000 (research, \$40,000; extension, \$20,000).

[Research.]

EXPERIMENTS IN DAIRYING AND LIVE-STOCK PRODUCTION IN SEMI-ARID AND IRRIGATED DISTRICTS.

Experiments in Dairying and Live-Stock Production in Semiarid and Irrigated Districts of the Western United States:

Object.—To investigate the problems encountered in establishing the industries of dairying and meat production in the semiarid and irrigated sections of the United States, particularly with reference to the effective utilization of the forage and grain crops produced in those regions.

Procedure.—It is proposed to inaugurate these investigations in the Great Plains area at five points where the Bureau of Plant Industry is now operating field stations for the investigation of problems of crop production, viz, Dalhart, Tex., dairying, and meat production with beef cattle and hogs; Scottsbluff, Nebr., meat production with hogs; Ardmore, S. Dak., dairying, and meat production with beef cattle and hogs; Belle Fourche, S. Dak., dairying, and meat production with beef cattle, hogs, and sheep; Huntley, Mont., dairying, and meat production with hogs, sheep, and poultry. The local responsibility will in each case be centered in the farm superintendent. At each place a competent animal husbandman will have charge of the animal-husbandry investigations, and at four places dairy herds will be maintained with a dairy husbandman in charge of each herd. The size of the herd in each case will be no larger than is necessary for the proper investigation of the special problems undertaken. Most of the feed and some of the equipment will be furnished, without additional cost, by the field stations maintained by the Bureau of Plant Industry. Such feed and equipment as are not so furnished will be purchased.

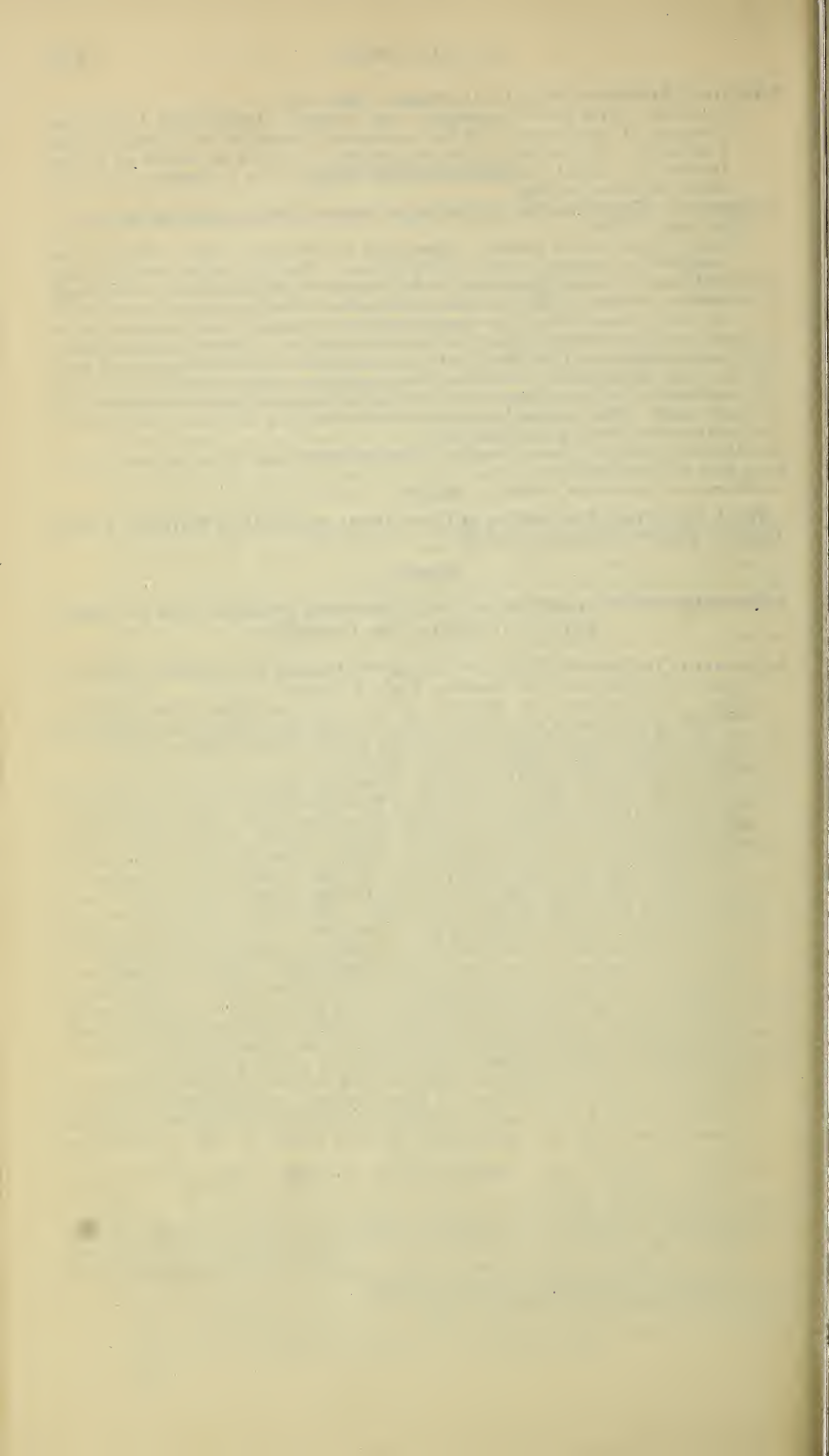
Cooperation.—The work will be organized and directed by the committee on cooperation between the Bureau of Plant Industry and the Bureau of Animal Industry, subject to the approval of the chiefs of the two bureaus, and in cooperation with the State experiment stations which are now cooperating at these field stations.

Location.—Dalhart, Tex., Scottsbluff, Nebr., Ardmore, S. Dak., Belle Fourche, S. Dak., and Huntley, Mont.

Date begun.—July, 1916.

Assignment.—Committee on cooperation between the Bureau of Plant Industry and the Bureau of Animal Industry: E. C. Chilcott, chairman, C. S. Scofield, and F. D. Farrell, of the Bureau of Plant Industry; and B. H. Rawl and G. M. Rommel, of the Bureau of Animal Industry.

Proposed expenditures, 1916-17.—\$40,000.



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